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URBAN RUNOFF POLLUTION CONTROL PROGRAM OVERVIEW FY76

MUNICIPAL ENVIRONMENTAL RESEARCH LABORATORY

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URBAN RUNOFF POLLUTION CONTROL PROGRAM OVERVIEW: FY '76

Municipal Environmental Research Laboratory
Office of Research and Development
U.S. Environmental Protection Agency
Cincinnati, Ohio 45268

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FY'76 review of EPA's Urban Runoff Pollution Control Research, Development, and Demonstration Program. The review describes: the basic pollution, flood control and soil erosion problems created by urban runoff; governmental administration and incentive problems; EPA R&D organizational structure; nationwide cost requirements to abate urban runoff pollution; available abatement technology along with ongoing and perceived developments; and, of overlying importance, program direction and desired goals are cited with intent towards a truer concept of solution methodology involving receiving stream impact analyses.

Details in summary and abstract form are presented covering the gamut of technologic advancements resulting from some 150 R&D projects. Stormwater management is broken down into the categories of: problem definition, user assistance tools, land management, collection system control, storage, treatment, sludge/solids, integrated systems, and technical assistance/technology transfer.

General cost comparisons for urban runoff pollution control/treatment are given along with a specific example of a cost-effect solution for urban runoff pollution control by in-line storage in Seattle, Washington, and a simplified hypothetical plan for wet-weather flow pollution abatement for the Des Moines, Iowa area.

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URBAN RUNOFF POLLUTION CONTROL

PROGRAM OVERVIEW FY76

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FOREWORD

The Environmental Protection Agency was created because of increasing public and government concern about the dangers of pollution to the health and welfare of the American people. Noxious air, foul water, and spoiled land are tragic testimony to the deterioration of our natural environment. The complexity of that environment and the interplay between its components require a concentrated and integrated attack on the problem.

Research and development is that necessary first step in problem solution and it involves defining the problem, measuring its impact, and searching for solutions. The Municipal Environmental Research Laboratory develops new and improved technology and systems for the prevention, treatment, and management of wastewater and solid and hazardous waste pollutant discharges from municipal and community sources, for the preservation and treatment of public drinking water supplies, and to minimize the adverse economic, social, health, and aesthetic effects of pollution. This publication is one of the products of that research; a most vital communications link between the researcher and the user community.

The report constitutes a review of EPA's R&D program for Urban Runoff Pollution Control. It describes completed work, ongoing work and future work required to abate pollution from wet-weather flows and presents the overall philosophy of approach to this specific problem as far as EPA's R&D program sees it.

Francis T. Mayo
Director
Municipal Environmental Research Laboratory

ABSTRACT

FY'76 review of EPA's Urban Runoff Pollution Control Research, Development, and Demonstration Program--The review describes the basic problems associated with urban runoff (both technical and administrative) and the approach that EPA's R&D program has and is taking to combat these problems. Information is presented on flood control, erosion control and the basic pollutional problems created by wet weather flows. Nationwide cost requirements for abating urban runoff pollution and available abatement technology along with ongoing and perceived developments are discussed. Of overlying importance is the presentation of EPA's research direction and desired goals oriented toward a truer concept of solution methodolog

Details in summary and abstract form are presented covering the gamut of technologic advancements resulting from some 150 R&D projects. Stormwater management is broken down into the categories of: problem definition, user assistance tools, land management, collection system control, storage, treatment, sludge/solids, integrated systems, and technical assistance/technology transfer.

General cost comparisons for urban runoff pollution control/treatment are given along with a specific example of a cost-effective solution for urban runoff pollution control by in-line storage in Seattle, Washington, and a simplified hypothetical plan for wet-weather flow pollution abatement for the Des Moines, Iowa area.

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WET-WEATHER FLOW R&D: WHY? (Illustration I)

Wet-Weather flow R&D: Why? A large portion of the water pollution load created by urban areas stems from storm-generated discharges.

Representative Concentrations

The average BOD concentration in combined sewer overflow is approximately one-half the raw sanitary sewage BOD. But storm discharges must be considered in terms of their shockloading effect due to their great magnitude. Even separate storm wastewaters are significant sources of pollution, "typically" characterized as having solids concentrations equal to or greater than those of untreated sanitary wastewater, and BOD concentrations approximately equal to those of secondary effluent. Bacterial contamination from separate storm wastewaters is also significant.

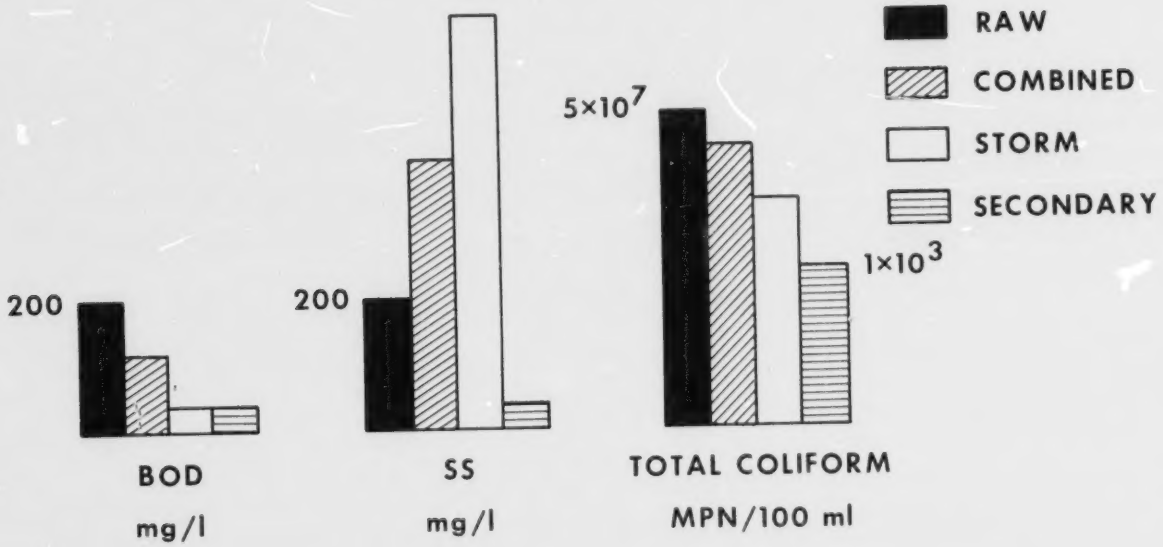
Representative Loads

(1) From 40% to 80% of the total annual organic loading entering receiving waters from a city is caused by sources other than the treatment plant.

(2) Assuming treatment plants are operating properly, during a single storm event, from 94% to 99% of the organic load and almost all settleable solids are attributed to WWF sources.

WET-WEATHER FLOW R&D : WHY?

REPRESENTATIVE CONCENTRATIONS



REPRESENTATIVE LOADS

- 40% TO 80% OF TOTAL ANNUAL BOD AND COD ENTERING RECEIVING WATERS CAUSED BY WET-WEATHER SOURCES OTHER THAN SECONDARY TREATMENT PLANT
- ASSUMING SECONDARY DWF TREATMENT, DURING STORM CONDITIONS
  - 94 TO 99% BOD, AND APPROX. 100% SETTLEABLE SOLIDS FROM CSO, SWD & NSR
  - SW MAJOR SOURCE OF PATHOGENS & BACT., & NUTRIENTS
  - TOXIC POLLUTANTS, PARTICULARLY HEAVY METALS, HIGH

(3) The runoff of toxic pollutants, particularly heavy metals, is high -- considerably higher than typical industrial discharges.

Potential Impacts (Illustration II)

Approximately 1/2 of the stream miles in this country are water quality limited and 30% of stream lengths are polluted to a certain degree with urban runoff. Hence, generally speaking, secondary treatment of DWF is not sufficient to produce required receiving water quality; and control of runoff pollution becomes an alternative for maintaining stream standards. Accordingly, both water quality planning and water pollution abatement programs need to be based on an analysis of the total urban pollution loads.

Until the urban stormwater situation is analyzed and efficient corrective measures taken, there is little or no sense in seeking higher levels of treatment efficiency in existing plants. For example,

- In Roanoke, VA domestic waste load removal was upgraded from 86% to 93%, yet there was no dramatic reduction in the BOD load (3.2 million pounds before upgrading compared to 3.1 million pounds after.)

- If Durham, NC provided 100% removal of organics and suspended solids from the raw municipal waste on an annual basis, the

POTENTIAL IMPACTS

- APPROXIMATELY ½ OF STREAM MILES IN THIS COUNTRY ARE WATER QUALITY LIMITED
- APPROXIMATELY 30% OF STREAM LENGTHS ARE POLLUTED WITH URBAN RUNOFF CHARACTERISTICS

HENCE

SECONDARY TREATMENT OF DWF IS NOT SUFFICIENT TO PRODUCE REQUIRED RECEIVING WATER QUALITY

AND

CONTROL OF RUNOFF POLLUTION BECOMES AN ALTERNATIVE FOR MAINTAINING STREAM STANDARDS

ACCORDINGLY

WATER QUALITY PLANNING & WATER POLLUTION ABATEMENT PROGRAMS MUST BE BASED ON TOTAL DRY & WET WEATHER POLLUTION LOADS

total reduction of pollutants discharged to the receiving water would only be 59% of the ultimate BOD, and 5% of the suspended solids.

These examples are for separate systems; however, communities with combined systems offer potentially greater pollutional impacts since additional loads come from domestic wastewaters, dry-weather sediment wash-out, and more impervious and populated lands.

PROBLEM (Illustration III)

Recognizing that WWF is a problem, the problem then becomes "how to approach the solution."

Sewer Separation

The concept of constructing new sanitary sewers to replace existing combined sewers has largely been abandoned due to enormous costs, limited abatement effectiveness, inconvenience to the public, and extended time for implementation. The use of alternate measures could reduce costs to about one-third the cost for separation. It is emphasized that sewer separation would not cope with the runoff pollution load.

PROBLEM

- SEWER SEPARATION
  - VERY COSTLY/TIME CONSUMING
  - DOES NOT ELIMINATE PROBLEM
- HIGH COSTS IMPLIED (ALTERNATES)
  - $25-30 BILLION FOR CSO CORRECTION (APWA, '74 NEEDS, NCWQ)
  - $235 BILLION FOR SWD CORRECTION ('74 NEEDS)
- NEW R&D ESTIMATES IMPLY LOWER COSTS

High Costs Implied

However, even in alternate approaches high costs have been implied. The 1974 Needs Survey identified national costs for abating combined sewer overflow pollution at $26 billion, or approximately one-fourth of the total for municipal sewage control. Similar costs have been indicated from other surveys. The cost for abating stormwater pollution was estimated at $235 billion.

There must be a more accurate assessment of the problem both nationwide and regional to provide the necessary foundation for policy and law making, and firmer pollution abatement targets -- realistically, can we do a job for the money we have?

New R&D Estimates Imply Lower Costs

A project nearing completion gives updated national cost estimates. For the first time, costs reflected more logical considerations, such as climate and degree of urbanization; pollution abatement of stormwater only and not separate, conventional flood control; and the fact that storage offers dual benefits of pollutant removal by settling. Nationally, costs for combined sewer overflow, and separate stormwater pollution control were $15 billion and $55 billion, respectively. The major reduction in the national figure for stormwater control may be attributable to discounting flood control. These new estimates are not final, and require more review; but the point

is, we should not shy away from separate stormwater research based on rough preliminary surveys, if what is required is better estimating procedures; especially when stormwater pollution is site specific, and its abatement may be cost-effective in certain areas of the country.

APPROACH (Illustration IV)

More Accurate Problem Assessment

Considering the limitations in the presently available data base, the first and most fundamental approach should be a more accurate assessment of the problem. Ideally, this should involve acquiring data on a city-wide basis for both DWF and WWF including upstream-downstream pollutant mass balances and the effects of the waste loads on the receiving waters.

Cost-Effective Approach

Integrated with a more accurate assessment is the consideration of cost-effective approaches to WWF pollution control.

Present abatement alternatives exhibit an extraordinary range of cost-effectiveness. For example, cost-effectiveness in terms of dollars/lb of pollutant removed for an alternative such as storage plus primary treatment, varies over a range of 75:1, depending on such

APPROACH (SOLUTION METHODOLOGY)

- MORE ACCURATE PROBLEM ASSESSMENT
  - NATIONWIDE/CITY-WIDE
  - RECEIVING WATER IMPACTS
  - SITE SPECIFIC
- CONSIDER ALL COST EFFECTIVE APPROACHES
  - COMPARE ALTERNATIVES (SITE SPECIFIC)
    - TERTIARY VS. WWF CONSIDERATIONS
    - STRUCTURAL VS. LAND MGMT. & NON-STRUCTURAL
    - INTEGRATED DWF/WWF SYSTEMS
  - INTEGRATE FLOOD/EROSION CONTROL TECH. WITH POLLUTION CONTROL TECH.
  - INTEGRATE LAND MANAGEMENT AND NON-STRUCTURAL TECHNIQUES
- OVERCOME ADMINISTRATIVE PROBLEMS
  - LOGISTICS
  - GRANT COVERAGE

factors as location and land costs, type and condition of sewerage systems, pollution loads, and type of storage configuration. This very high cost-effectiveness variability demonstrates the irrationality of any attempt to prescribe uniform national standards for the technology of total urban load abatement as opposed to requiring site-specific studies.

There is an excellent opportunity to bring down the high costs implied for storm flow control.

The most cost-effective solution methodology must thoroughly consider:

1. Wet weather pollution impacts in lieu of blindly upgrading existing municipal plants.

2. Structural vs. land management and non-structural techniques. Studies have indicated that it may be cheaper to remove pollutants from the source by such measures as street, catch basin, and sewer cleaning than by eliminating them by downstream treatment. Certain land use, zoning, and construction site erosion control practices are other ways of alleviating the solids burden to the receiving stream or treatment plant; and

3. Integrating dry and wet-weather flow systems to make maximum use of the existing sewerage system during wet conditions and also maximize the utilization of wet-weather control/ treatment facilities during dry weather.

Until two important philosophies are allowed to prevail, the high cost implications for wet-weather pollution abatement will continue. First, flood and erosion control technology must be integrated with pollution control technology so that the retention and drainage facilities required for flood and erosion control can be simultaneously designed for integrated dual-benefits of pollution control. Second, if we maximize and integrate land management and non-structural techniques there will be less to pay, for the extraction of pollutants from storm flows in the potentially more costly downstream plants.

Overcome Administrative Problems

It is essential to include these concepts if we are to handle the job properly. But, there are basic problems in administration that have to be overcome.

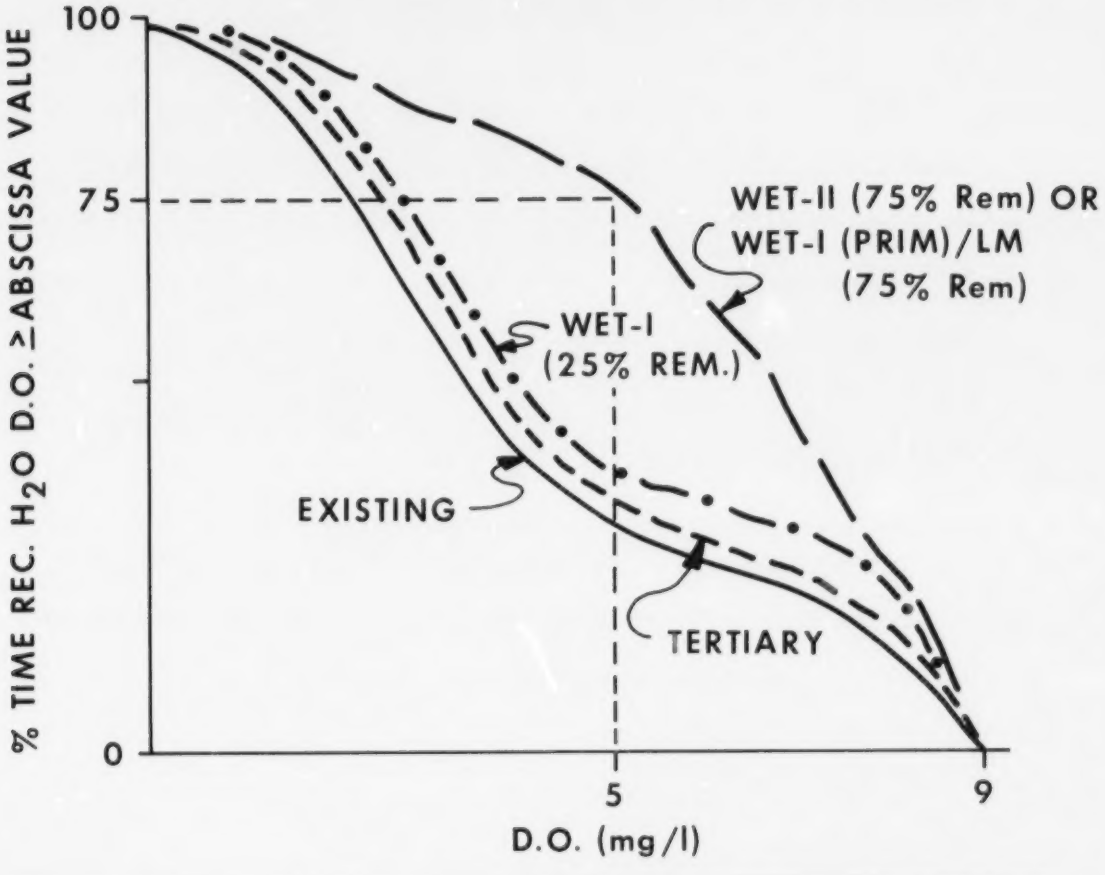
Logistics -- we have to integrate the autonomous Federal and local agencies and professions involved in flood and erosion control, pollution control, and land management and environmental planning from the standpoints of both planning and operation.

Grant Coverage - must be adequate to stimulate an integrated approach. For example, EPA would have to join with the Corps, Soil Conservation Service, and perhaps other agencies at the Federal level as well as departments of pollution control, sanitation, planning and flood control at the local level. EPA's present policy of funding facilities construction will need expansion to cover cost-effective land management and non-structural techniques promulgated by its planning grant approach.

SOLUTION METHODOLOGY (Illustration V)

I will attempt to show one approach to cost-effective solution methodology on a hypothetical basis. These curves represent percentages of time receiving water D.O. is greater than or equal to a D.O. level of the abscissa. They should represent at least one year's continuous flow of data. This case is for D.O. but actual studies should include other parameters. By this analysis we can make true cost-effectiveness comparisons based on total time of receiving water impacts and associated abatement costs. For example, if we desire 5 mg/l D.O. in the receiving water 75% of the time as a standard, then we need to go to an advanced form of wet-weather treatment, or primary wet-weather treatment integrated with land management. The latter is the most cost-effective at $3M. This or similar methodologies can help us set cost-effective standards as well as select alternatives.

SOLUTION METHODOLOGY



CONTROL ALTERNATIVES	% BOD REMOVAL		COST ($\$\times10^6$)
	DRY WEATHER	WET WEATHER	
EXISTING	85	0	–
TERTIARY	95	0	6
WET-I (PRIMARY)	85	25	1
WET-II (ADV)	85	75	6
WET-I/LAND MGMT.	85	75	3

STORM AND COMBINED SEWER PROGRAM (Illustration VI)

This schematic portrays the Storm and Combined Sewer Program breakdown for FY 76. The objective is Runoff Pollution Control which has three sub-objectives: (1) Combined Sewer Pollution Control, (2) Sewered and Unsewered Runoff Pollution Control, and (3) Hydrologic Modification.

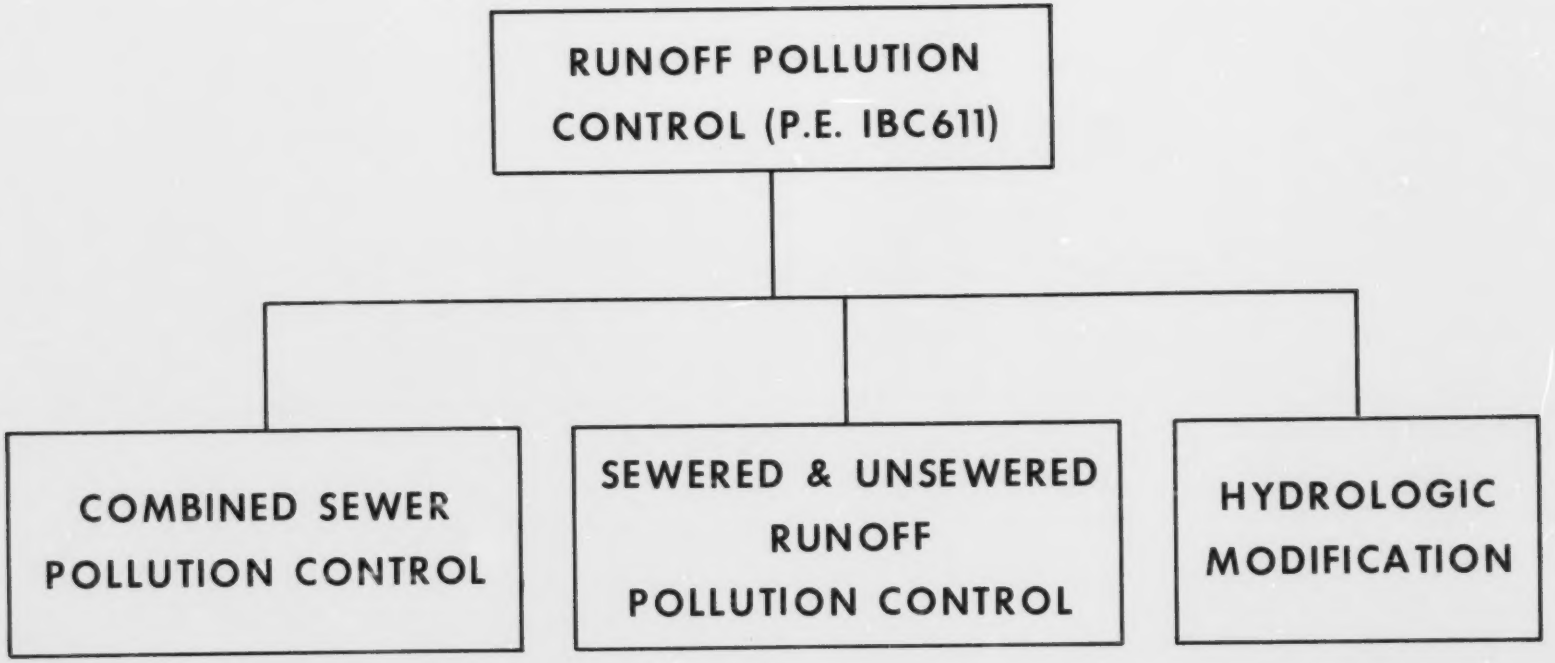
MODES OF CONVEYANCE (Illustration VII)

In formulating a programmatic approach for runoff pollution control we feel it is advantageous to look at the problem from the point of view of modes of conveyance: i.e.

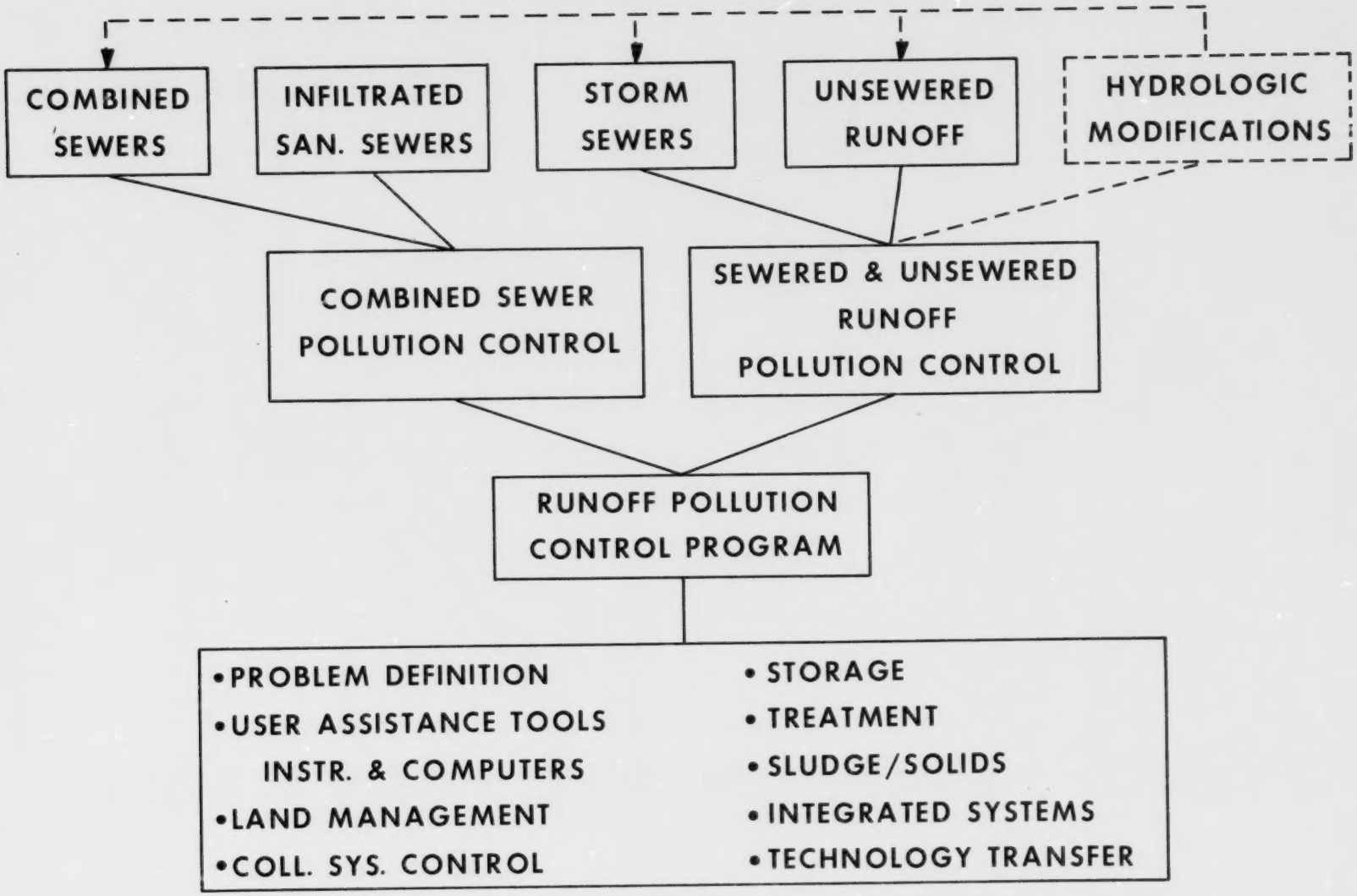
- combined sewers
- infiltrated sanitary sewers
- storm sewers, and
- unsewered runoff

Hydrologic modifications considers control technology for such activities as construction, dredging, landfill, and water resources development. It does not logically fit into the "modes-of-conveyance" approach to runoff pollution control. The effects of hydrologic modifications are felt in combined sewers, storm sewers and unsewered runoff and the technology for sediment/erosion control and pollutant/flood control must be integrated for stormwater. In fact, the program has always considered silt-laden stormwater from construction as a constituent and source of pollution.

STORM AND COMBINED SEWER PROGRAM (FY '76)


RUNOFF POLLUTION CONTROL (P.E. IBC611)
COMBINED SEWER POLLUTION CONTROL
SEWERED & UNSEWERED RUNOFF POLLUTION CONTROL
HYDROLOGIC MODIFICATION

MODES OF CONVEYANCE FOR RUNOFF POLLUTION



Hence it makes more sense to break the program into two major areas:

- Combined Sewer Pollution Control covering combined sewers and infiltrated sanitary sewers, and
- Sewered and Unsewered Runoff Pollution Control covering storm sewers, unsewered runoff, and hydrologic modifications.

In formulating an approach methodology it is also advantageous to recognize the similarities between these two areas. The characterization of the combined sewer overflow and stormwater problems is similar, for it is merely a qualification and quantification of storm flow independent of the sanitary constituent. The same instruments or users assistance tools are applied to combined sewer overflow and stormwater. Land management and non-structural pollutant source removal techniques are the same, independent of whether the runoff enters a combined or separate system. The control or treatment hardware although mainly developed for combined sewer overflow has high trade-off potential for stormwater. The basic philosophy in applying countermeasures or solution methodology is also independent of the mode-of-conveyance.

Also, all communities have intermingled systems; i.e., sanitary sewers discharging into storm drains, storm drainage going into sanitary lines via infiltration/inflow, or sanitary sewers discharging into combined sewers, and vice versa.

Accordingly, the Runoff Pollution Control Program as I will present it today will be divided into the following technical areas of consideration, common to both major elements, Combined Sewer Overflow Pollution Control, and Sewered and Unsewered Runoff Pollution Control: Problem Definition, User Assistance Tools (Instrumentation, Computers), Land Management, Collection System Control, Storage, Treatment, Sludge and Solids, Integrated Systems, and Technical Assistance and Technology Transfer.

Please refer to Illustration VIII of your handout which ties the categories together for a complete picture while I discuss each category individually with the help of visual aids. There have been many projects under the program -- about 150, so I only have time to highlight a basic program direction by citing significant completed and ongoing work, present fiscal year and future tasks.

PROBLEM DEFINITION (Illustration IX)

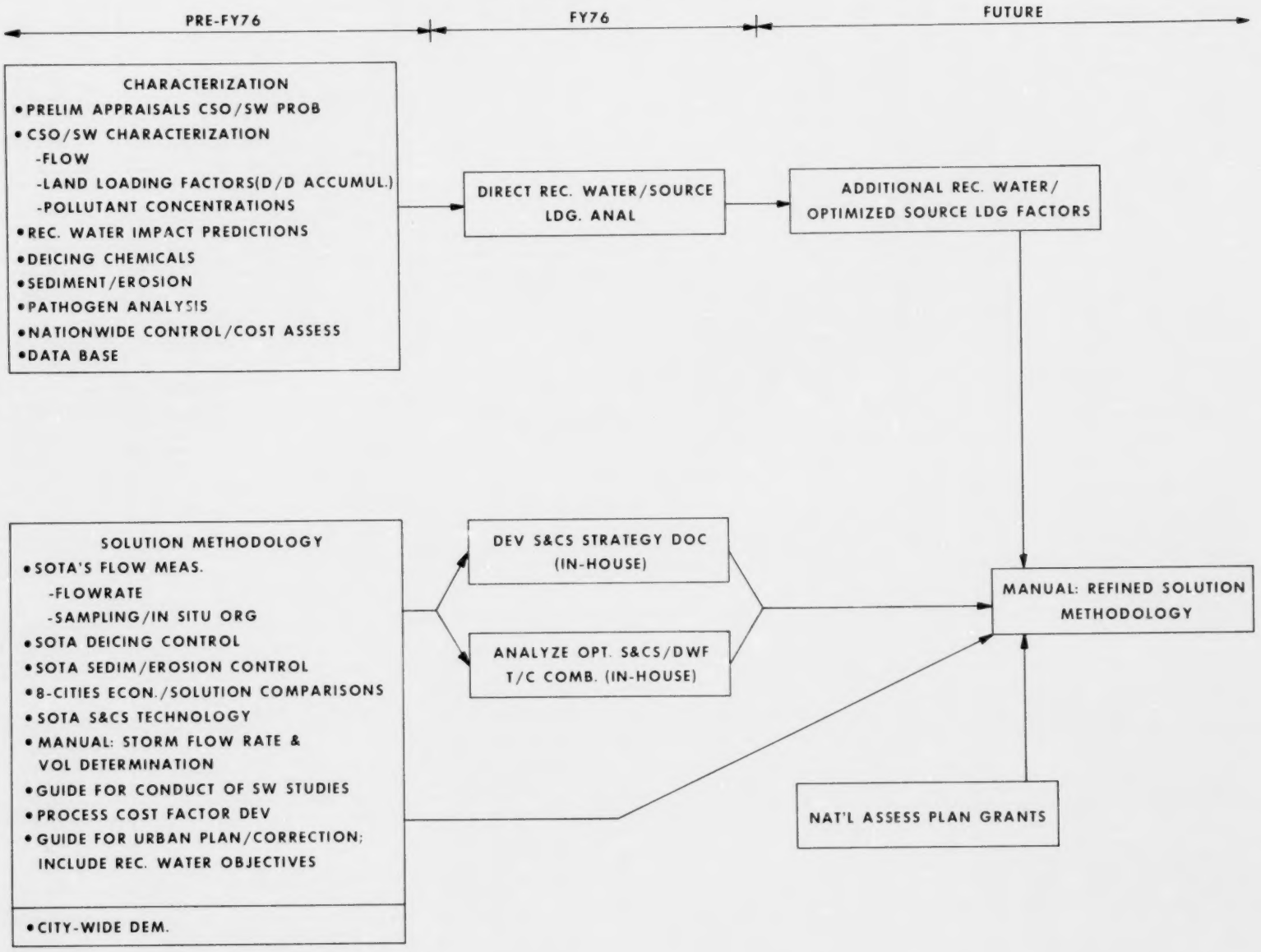
The program starts with "Problem Definition" broken into "Characterization" and "Solution Methodology."

Characterization

Under "Characterization" the S&CS Program started as a result of the original PHS problem study completed in 1964. Since then more detailed appraisals confirmed the problem. Past characterization studies for storm flow give a data base for pollutant source

CATEGORIES	INITIATED/ACCOMPLISHED	FY 76 (EXTRAMURAL BUDGET $800K)	FY 77 (EXTRAMURAL BUDGET $875K)	POST - FY 77
PROBLEM DEFINITION				
Characterization	Prelim. appraisals CSO/SW prob., CSO/SW char., deicing, sed./eros., loading factors, rec. water impacts, nat'l assess. impacts/costs	-Direct rec. water/source loading factor analysis -Dev. S&CS strategy document -Analyze optimum S&CS/DWF T/C combinations	-Direct rec. water impacts/assess source loading/ accum. factors	-National assessment of planning grants -Refined solution methodology manual -City planning/wet-weather impacts
Solution Methodology	SOTA S&CS tech., plan/select guide, conduct of SW studies, SOTA's sed./eros. & deicing control, unit cost factor dev.			
USER ASSISTANCE TOOLS				
Instrumentation	Raingage, flow measuring, sampling, monitoring, control	-Verif. magnetic flowmeter for simultaneous press/ gravity flow meas. (supplement) -Demo in-situ TOC anal. & storm flow sampler (Syracuse-supplement) -Dev. syst. analysis program for quantification/hand- ling of CSO sludge/solids -Dev. autom. oper. model for real-time control w/rain fall predict. -Hydr. model for steep slopes (supplement)		-CSO instru. eval. (FMC or Cushing test loop) -Radar: rainfall forecasting for operational control -Optimize diversion gates for sewage routing -Dev./Demo urban water mgmt model (UWMM) w/User's manual
Simulation Models	Simplified, detailed/complex, operational, dissemination			
LAND MANAGEMENT	NON-STRUCTURAL:			
Retention/detention	Land use planning, upstream impoundment (struc- tural), porous pavement	-Eval. effect of sed. trapping efficiency of off- stream det./ret. -Demo in-situ hydrophobic substance -Demo sed./eros. control techniques in SE USA (supplement) -Demo improved street cleaning practices (or FY 77)	-Demo improved street cleaning practices (if not funded FY 76) -Demo sed./eros. control in northern plains, US -MOP for pollution control from construction activities	-Manuals of practice: land mgmt, highway constr., overall
Enforced controls	Air pollution, eros./sed., cropping, berms, chemical use, hydrophobic, deicing			
Neighborhood sanitation	Street cleaning, solid waste management			
COLLECTION SYSTEM CONTROLS				
Sewer separation	May require separate treatment system	-Demo periodic sewer flushing: CSO 1st flush relief -Eval. strength increases from sulfur impregnation of concrete pipe -Dev. autom. operational model for real-time control w/rainfall predict.	-Demo periodic flushing of CSO (if not funded FY 76)	-Demo fully automatic control -Demo "Smisson" pump-separator concept
Runoff inlet/catch basin	Effectiveness eval., improved design, cleaning			
Sewers	"First flush" relief: flushing/cleaning, new designs (low flow carrying vel. and added storage), I/I pre- vent and control (with manuals), polymers to in- crease capacity			
Improved regulators and tide gates	Positive control, increased diversion to treatment, swirl & helical, fluidic reg.			
Remote monitoring with supervisory control	Provides storage/discharge options			
Fully automated control	Automates storage/discharge options			
STORAGE				
In-Line	Use excess sewer capacity			-Design manual for storage facilities -Demo new config. (silo, underwater bags, flow routing) -Eval. seepage basins for recharge -Eval. dual storage for DWF/WWF w/sec. polishing
Off-Line	Surface (rect. tanks, earthen basins, abond. quar- ries), subterrain. (natural formations, silos & tunnels), underwater, solids impacts			
TREATMENT				
Physical treatment with and without chemicals	Fine screening, microstraining, sed., filt., dis- solved air flotation, swirl/spiral separation	-Demo fine screening/microstraining, swirl reg. and high-rate disinf. by ClO_2/Cl_2 and mixing incl: resid. toxic/carcinogenic Cl_2 comp. viral disinf. eval.) (Syracuse-supplement) -Feas. of land disposal (Envirex-supplement)	-Eval. dual use DAF/contact stabilization facility for treating DWF/WWF (san. infilt.) (Clatskanie, OR) (if funds not avail. FY 76)	-Hi-rate filt. of CSO and raw DWF demo -Pilot full-scale: land disposal CSO/SWR -Demo helical flow reg./solids-liq. separator -Dev./Eval. dual DWF/WWF fluidized bed columns for carbonaceous matter removal (NYC) -Demo full-scale magnetic separation system
Biological treatment	Contact stabilization, trickling filters, lagoons, rotating biological contactors. Generally assoc. w/continuously operated plant			
Physical-chemical	Precipitation, filtration, adsorption, ion exchange, break-pt Cl_2			
Disinfection	Chlorination, hypochlorination, ozonation, chlorine dioxide, on-site gen., high-rate, mixing, micro- organism indicator study (pathogen, virus), 2-stage			
Land disposal	Marsh land			
SLUDGE/SOLIDS				
Characterization/Quanti- fication	Classification requirement, treatability, vital parameters, amount, solids content	-Evaluate: methods of ultimate disposal of WWF solids and impacts of WWF sludges/solids on DWF plant (Envirex-supplement)		-Pilot full-scale: land disposal storm flow solids -Demo new sludge/solids handling (swirl, etc.) -CSO sludge toxicity study
Treatment handling schemes	On-site vs DWF trmt., land disposal			
Process evaluations	Thickening, digestion, centrifugation, vacuum filtra- tion, incineration			
INTEGRATED SYSTEMS (Varies)	Most common master plan approach			
Storage/treatment	Pump-back, sed. in storage, disinfection, break-even econ. w/treatment		-Demo city-wide treatment-park concept for CSO control (Mt. Clemens, MI - piggy-back) -Eval. dual use DAF/contact stabilization facility for treating DWF/WWF (san. infilt.) (Clatskanie, OR) (if funds not avail. FY 76) -Demo dissolved air flotation for DWF/WWF treat. (funded by others)	-Demo storage-treat.-recharge -Eval. central dual use (WWF/DWF) microstraining treatment (ORD to ride piggy-back) -Dev./eval. dual DWF/WWF fluidized bed columns for carbonaceous matter removal (NYC) -Eval. dual storage for DWF/WWF with sec. polishing
Dual use WWF/DWF (storage/ treatment	Lagoon storage/treat., HRTF, contact stab., P-C, hi- rate filter, equalization, combined sewers			
Control/treatment/reuse	Treatment-park, new town devel. (land mgmt-treat), storage/treat. marina feas., lakelets for storage/ treat./reuse			
TECHNICAL ASSISTANCE AND TECHNOLOGY TRANSFER		-Continuous (15% - 20% of prog. time) NOTE: Anticipate increase in EPA construction grant (201) and planning grant (208) assist. due to CSO emphasis	-Continuous	-Continuous
Consultation to Fed., state, local govts. and quasi-govt. agencies	EPA, OAWP (needs surveys): EPA TT (seminars, film production); EPA Reg. receiving H_2O impact studies; EPA Hq and Regions on 201/208 studies and seminars; Reg. V on 108 grants; NSF, DOT, OWRT (reviews, confer, steering committees); CEQ & NCWQ (proposal and rept reviews, joint nat'l assess. projects)			
Public Inf. Requests	Documents, lectures, films, confer., articles, re- ports, example methodology for prob. solution, conf. moderator, prog. committees			
Consultation to foreign govt. and international confer.	TT (France, Japan, Denmark, Norway, Sweden, Canada, Netherlands, Australia, New Zealand); Canadian (TAG) IJC (steering com.) IAWPR (confer. & prog. commit- tees); various conferences and publications			
In-House seminars	Various tech. areas; overviews			
SWMM	Short course,; user's assistance manuals/dissem- ination			
Higher Education	SCS prog. university course man.			
Planning/design/SOTA/ assess manuals and extra- mural publications	Overall prog. concepts, sol. method, sampling/anal., costs, specific processes			

PROBLEM DEFINITION



accumulation and hydraulic loads. With these loads, resultant receiving water impact analyses further defined the problem. A total data base and retrieval system is being developed by separate contract. Special characterization studies were carried out for deicing salt, sediment/erosion, and pathogenic impacts from storm flows. The importance of a more refined nationwide wet-weather pollution impact and abatement cost study was previously mentioned.

Solution Methodology

Solution Methodology naturally followed initial characterization for providing uniform and necessary background for the user community. Highlights, are the often referenced SOTA's on storm flow measuring and sampling, along with those for deicing and erosion control.

Eight separate city studies each on an economic comparison of pollution control alternatives portrayed various concepts and the municipal approach. The recently completed text on urban stormwater management and technology is considered an excellent program milestone and guide for planners and engineers. It is being updated and will cover comprehensive guidance for total city-wide, wet-weather pollution control planning and countermeasure selection. Separate engineering manuals for urban storm flow and volume determination, and for the conduct of stormwater studies have just been completed.

These along with the other solution methodology documents are serving for 201 and 208 studies. A city-wide demonstration on multi-faceted approach methodology is being conducted in Rochester to serve as an example for other cities.

This fiscal year we are endeavoring to study direct receiving water impacts, along with further development of source loading factors (and verification of a water quality model). This project will serve as an important demonstration by lending credence to the implications of storm flow impacts. We are currently in the process of selecting a demonstration project, with a possibility of riding piggy-back under 201 and 208 projects in Milwaukee, Philadelphia, or Syracuse. We have also included receiving water impacts in an ongoing project in Lancaster, PA and received additional non-EPA funds to conduct a receiving water impact analysis for the ongoing Rochester project. It is felt that more than the $165K slated for impacts will be required by next year because of the complex sampling and analysis, and multi-site coverage necessary to meet our objectives.

Dr. Brunner has previously introduced our present in-house study on an analysis to optimize wet and dry-weather flow treatment and control combinations. This work will also help develop an in-house strategy document this fiscal year.

In FY 78 we would like to initiate an assessment of the various 201 and 208 planning grants, and later a refined manual on solution methodology culminating our objectives in the area of problem definition.

USER ASSISTANCE TOOLS

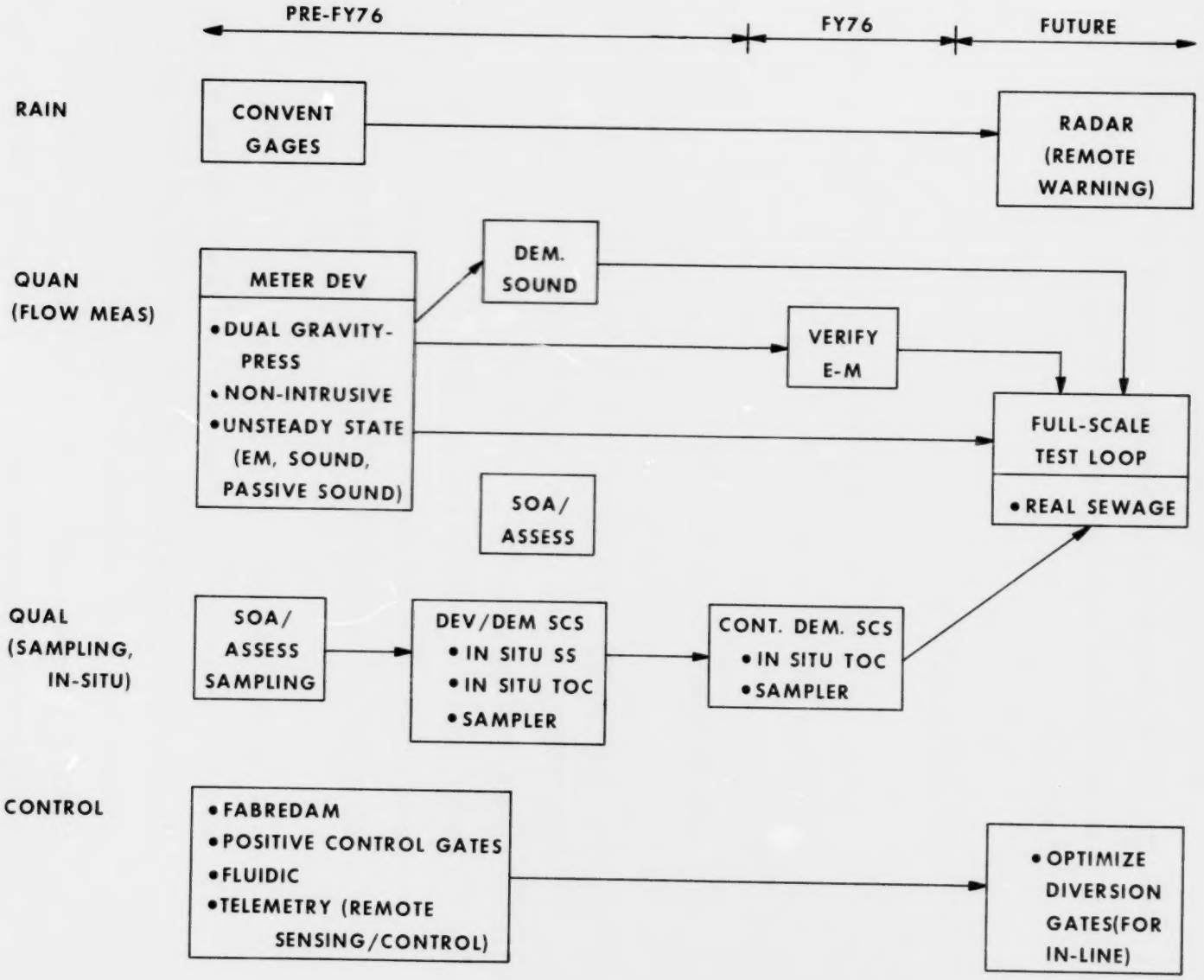
User Assistance Tools: the category is divided into "Instrumentation" and "Simulation Models."

Instrumentation (Illustration X)

The qualitative and quantitative measurement of storm overflows is essential for process design, control, evaluation, and enforcement. "Urban intelligence systems" require real-time data from rapid remote sensors in order to achieve remote control of a sewerage network. Sampling devices do not provide representative aliquots, and in-line measurement of suspended solids and organics is needed.

The electromagnetic, ultra-sound, and passive sound flowmeters which have been developed and demonstrated overcome adverse storm flow conditions (which require dual pressure-gravity measurement of unsteady flows by non-intrusive instrumentation). Further demonstration of the electromagnetic flowmeter will take place this fiscal year by a contract continuation. A prototype sampler for capturing representative solids in storm flow, and overcoming storm flow

INSTRUMENTATION FOR TOTAL SYSTEM MGMT



adversities, has been developed and compared with conventional samplers. Favorable results have been obtained and a design manual is available. Demonstration of two previously developed rapid, in situ monitoring devices for suspended solids and TOC is nearing completion. Preliminary tests have been successful. In FY 76 part of a continuation for a demonstration grant in Syracuse includes additional verification of the sampler and TOC analyzer.

Separate SOTA reports for flow measurement and sampling have been mentioned under problem definition.

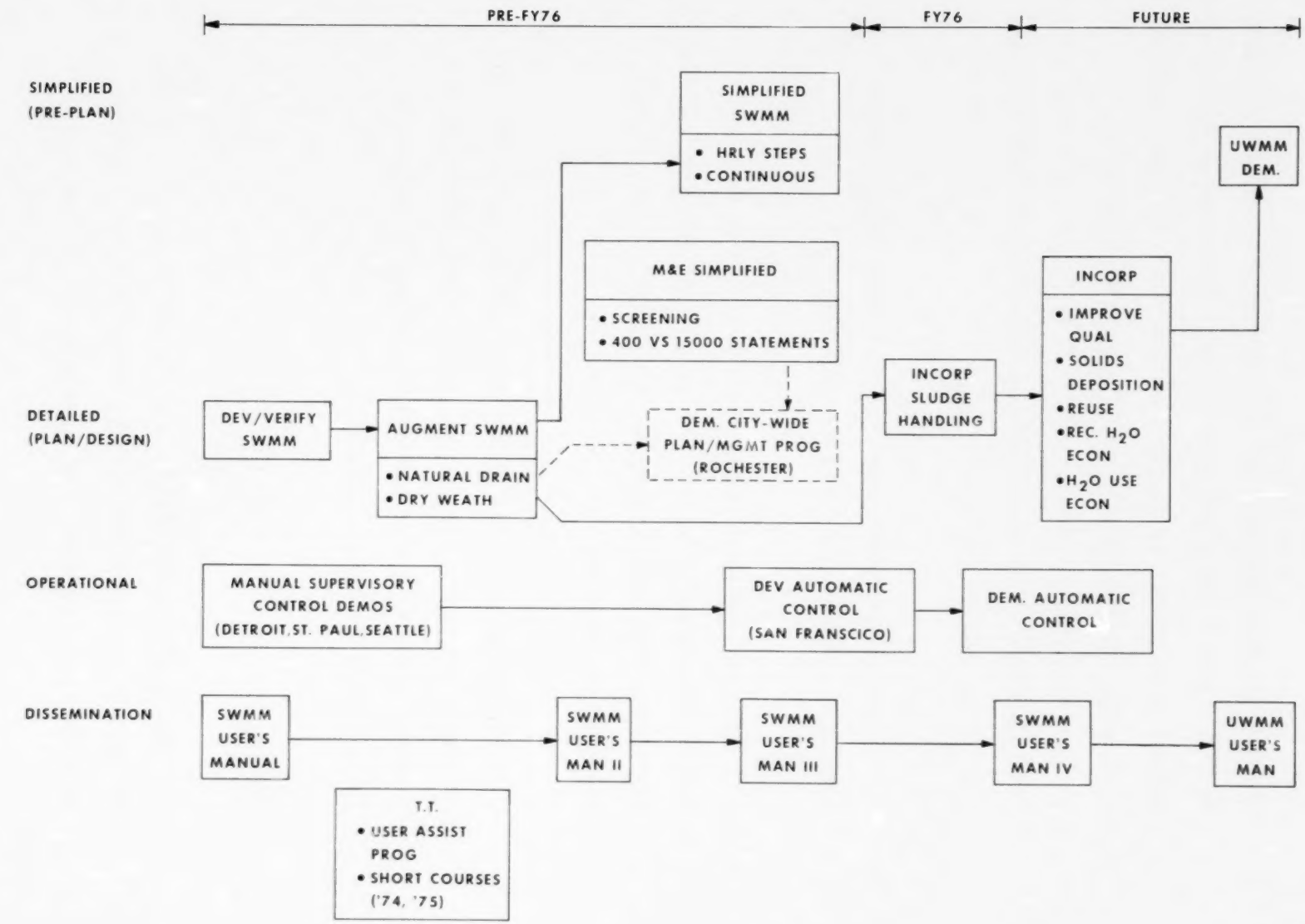
The instrumentation effort seems to be coming to a head, but before that, it would prevail upon us to reactivate our full size test loop in the possession of FMC for further testing of S&CS program developed, and other instrumentation.

(Remote raingaging by radar; and optimization of control gates to enhance automatic flow routing, a need coming out of the EPA Clemson University Instrumentation and Automation Seminar, will be considered for future projects.)

Simulation Models (Illustration XI)

Math models are needed to predict complex dynamic responses to variable and stochastic climatological phenomena. Models have been subcategorized into three groups: (1) simplified

SIMULATION MODELS FOR TOTAL SYSTEM MGMT



for preliminary planning, (2) detailed for planning and design, and (3) operational for supervisory control.

We have demonstrated the benefits of the Storm Water Management Model, SWMM, for detailed planning and design. As the schematic shows, SWMM is being augmented to include natural drainage routing and integration of DWF facilities. WWF sludge quantification and handling will be incorporated this fiscal year by a grant continuation.

A simplified SWMM model has just been developed which can run continuously on a year's data, on hourly time steps to cover wet and dry-weather periods and allow for continuous receiving water impact analyses. A more simple model with only a few hundred statements has been developed for alternative control screening (by M&E) under the Rochester project. This model is being tied together with SWMM to demonstrate a cost and time saving modeling approach for city-wide master plan development.

We would like to end the modeling program with the Urban Water Management Model (UWMM) by expanding SWMM to include the needed concepts of reuse, and receiving water and water use economics.

There is a defined program for operational models. We have demonstrated supervisory control models in Detroit, St. Paul, and Seattle; and have recently started on a program in San Francisco riding piggy-back with a $100 million construction grant, to

develop a fully automated operational model which includes rainfall prediction. The total EPA R&D cost is $195K, of which $130K is being awarded this fiscal year.

The technical dissemination program for models includes users manuals, revised at critical junctures, and technology transfer previously set up under a grant to the University City Science Center, and three short courses and manuals conducted and prepared under another continuing grant.

LAND MANAGEMENT (Illustration XII)

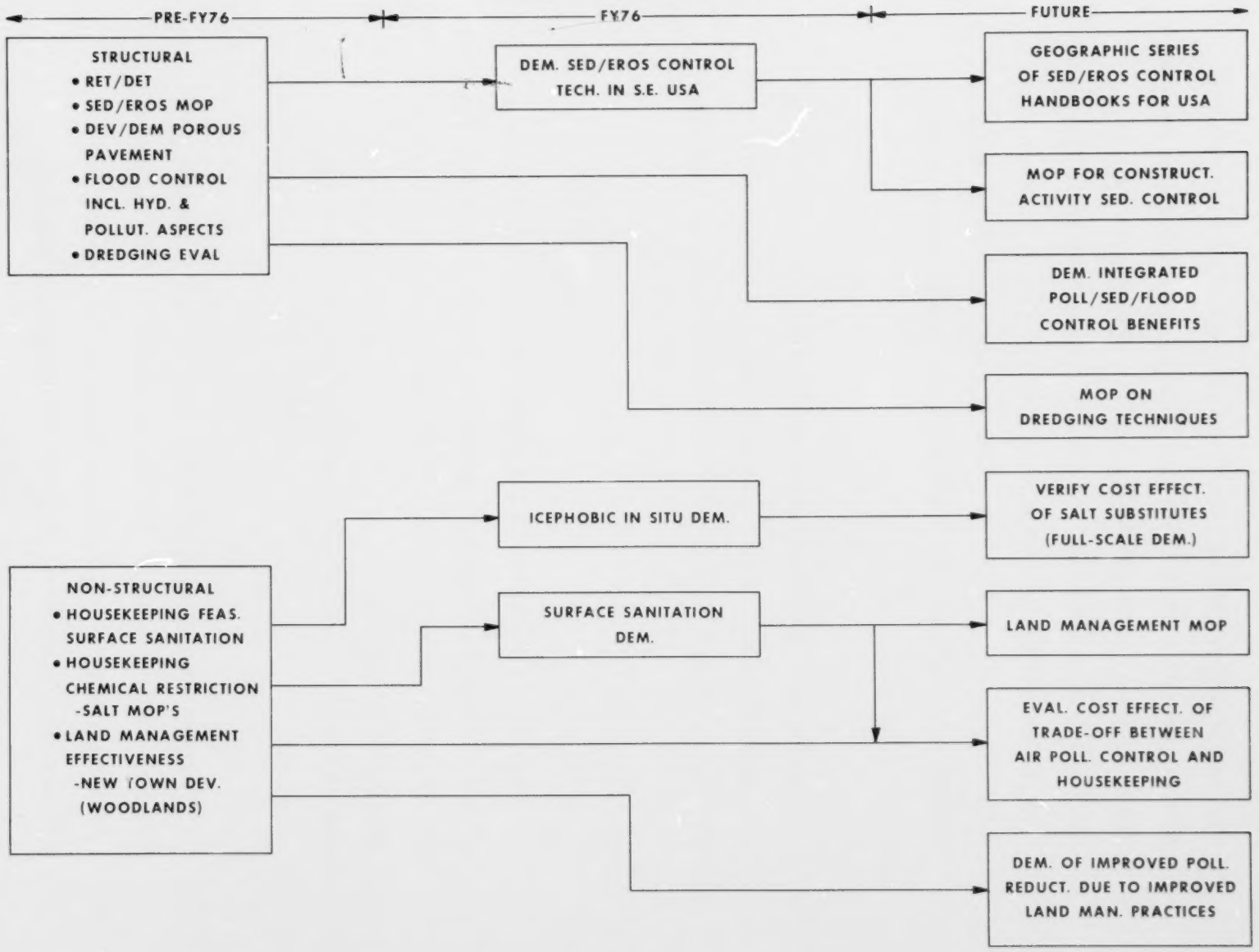
The next category, "Land Management" is broken into "Structural" and "Non-Structural" controls.

"Land Management" includes all measures for reducing storm-water pollution before urban runoff enters the sewer system. Included, are measures that affect both the quantity and quality of urban runoff.

Structural

Conventional flow control measures, mostly "structural" in nature, include upstream earthen impoundment, and sediment and erosion control. Other forms of upstream detention include roof-top storage and temporary use of recreational lands. New concepts,

LAND MANAGEMENT


PRE-FY76
FY76
FUTURE
STRUCTURAL
• RET/DET
• SED/EROS MOP
• DEV/DEM POROUS PAVEMENT
• FLOOD CONTROL INCL. HYD. & POLLUT. ASPECTS
• DREDGING EVAL
DEM. SED/EROS CONTROL TECH. IN S.E. USA
GEOGRAPHIC SERIES OF SED/EROS CONTROL HANDBOOKS FOR USA
MOP FOR CONSTRUCT. ACTIVITY SED. CONTROL
DEM. INTEGRATED POLL/SED/FLOOD CONTROL BENEFITS
MOP ON DREDGING TECHNIQUES
NON-STRUCTURAL
• HOUSEKEEPING FEAS. SURFACE SANITATION
• HOUSEKEEPING CHEMICAL RESTRICTION -SALT MOP'S
• LAND MANAGEMENT EFFECTIVENESS -NEW TOWN DEV. (WOODLANDS)
ICEPHOBIC IN SITU DEM.
SURFACE SANITATION DEM.
VERIFY COST EFFECT. OF SALT SUBSTITUTES (FULL-SCALE DEM.)
LAND MANAGEMENT MOP
EVAL. COST EFFECT. OF TRADE-OFF BETWEEN AIR POLL. CONTROL AND HOUSEKEEPING
DEM. OF IMPROVED POLL. REDUCT. DUE TO IMPROVED LAND MAN. PRACTICES

such as porous pavement and the integration of flood with pollution control technology should also be included. By temporarily detaining runoff upstream, drainage can be reduced, resulting in less flow to store and treat downstream. If this is coupled with retaining runoff from pervious areas for percolation into the ground, then the total volume of water entering the drainage system is reduced. Hence, considerable savings in both operation and initial construction costs will result.

During this fiscal year it is anticipated that funds will be used to continue an evaluation of sediment and erosion control techniques. Future projects should provide a series of handbooks.

Non-Structural

Quality control measures are mostly "non-structural," and include housekeeping or surface sanitation, chemical use restriction, air pollution control, and careful consideration of land use, development and zoning. Certain sediment and erosion control measures, such as cropping and berming may be considered non-structural.

Previous studies have shown the water pollution aspects of street surface contaminants and the importance of good neighborhood sanitation practices. Significant amounts of toxic substances were detected in the finer fraction of street dust and dirt.

Conventional street sweepers are inefficient in removing this fraction indicating a need for improved street cleaning equipment. Our program is planning a surface sanitation demonstration project this fiscal year or during FY 77.

Deicing chemicals will be mentioned later.

Careful consideration must be given to land use planning. -- Urbanization accelerates hydrograph and pollutograph peaks by creating impervious surfaces for pollutants and water to run off from. Future projects should be concerned with optimizing land use and resultant cost effectiveness. As previously discussed, the use of natural drainage concepts reduces drainage costs, enhances aesthetics and flood protection, and lowers pollution. Our new town development project near Houston is providing coverage in this area.

Future work should continue to demonstrate improved land management and surface cleaning practices for pollution reduction including air pollution aspects. We are presently trying to recruit interest from EPA air pollution research on our proposed project to demonstrate water and air quality benefits from street cleaning. Your help in this effort will be appreciated. Manuals of practice must be obtained in all areas of land management.

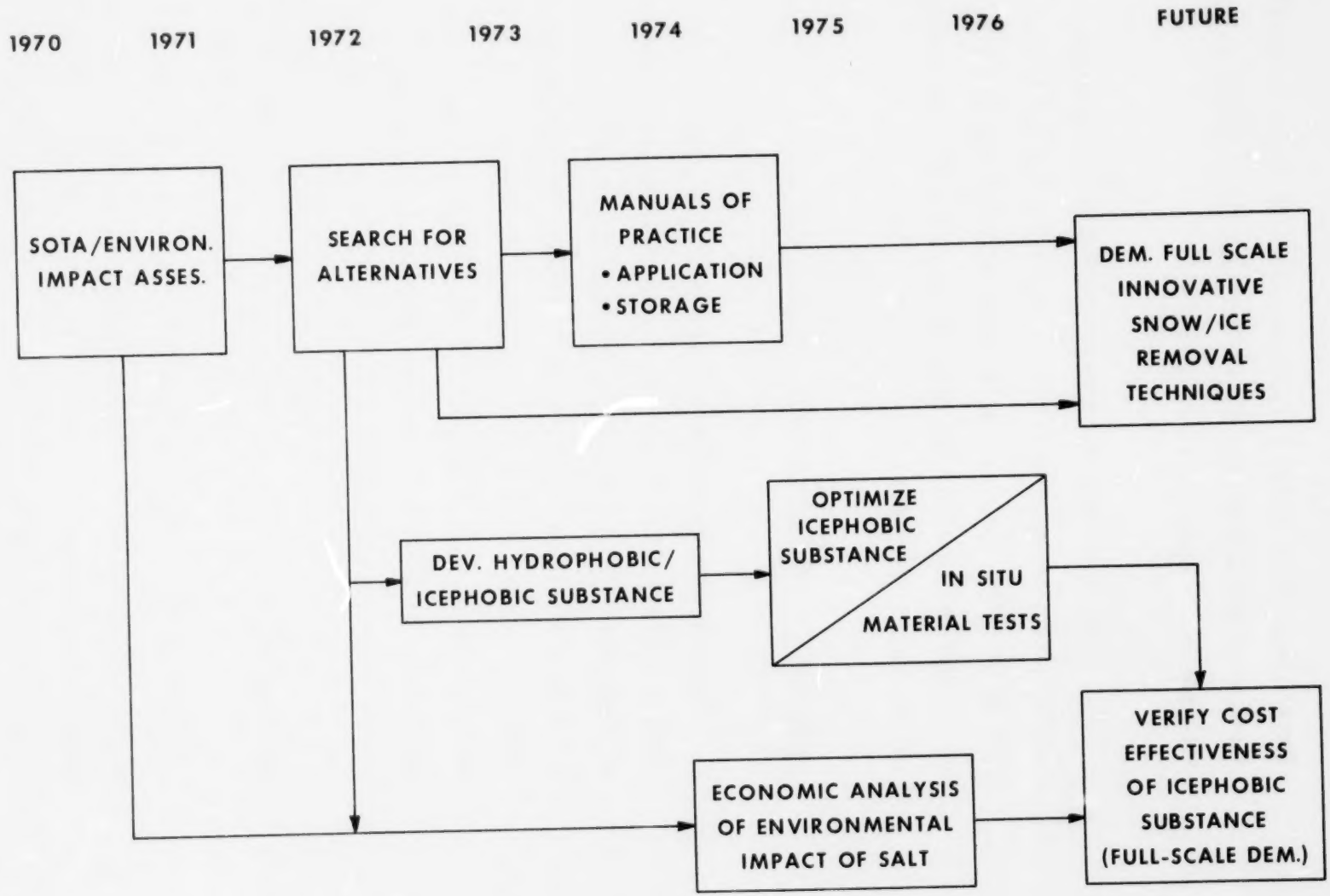
Deicing Chemical Control (Illustration XIII)

Until the SCS Program's SOTA report in 1971 there had been only limited research on highway deicing effects. Inquiries concerning this work indicated such an increasing public awareness of the salt problem, that it seemed appropriate to reexamine the environmental issues in much greater depth. The resulting recommendations firmed the basis for further salt work.

During 1972, a search was conducted to define alternatives for ice control. The results indicated the need for an accurate cost-benefit analysis of alternative approaches, and a requirement to identify a substance which can be applied to pavement to reduce ice adhesion. These two needs became projects, both nearing completion. During this fiscal year optimization and demonstration of an icephobic substance (organo-silicone, Dow Corning DRI-SIL 73) is anticipated. Even though material and application costs of this new substance appear greater than salt, the economic analysis has indicated that when considering total damage to the environment (including paved areas, highway structures and vehicles) the costs are acceptable.

After the 1971 SOTA, the program recognized that it was not practical to ban salt since the "bare pavement" philosophy was very popular and considered by many highway authorities as the safest way for ice and snow removal. Since the major problems were identified with sloppy salt storage practices and over-application on highways a contract was awarded in 1974 to produce manuals of practice in

DEICING CHEMICAL CONTROL (LAND MANAGEMENT/NON-STRUCTURAL)



these areas. These manuals became available in 1975 and recognizing their value and popularity, the FHWA requested permission to reprint the manuals for their own distribution.

It is believed that the outcome of our work has prompted several states to enact legislation controlling the application and storage of salt. In the future we hope to verify the cost-effectiveness of an icephobic substance and demonstrate full-scale innovative snow and ice removal techniques.

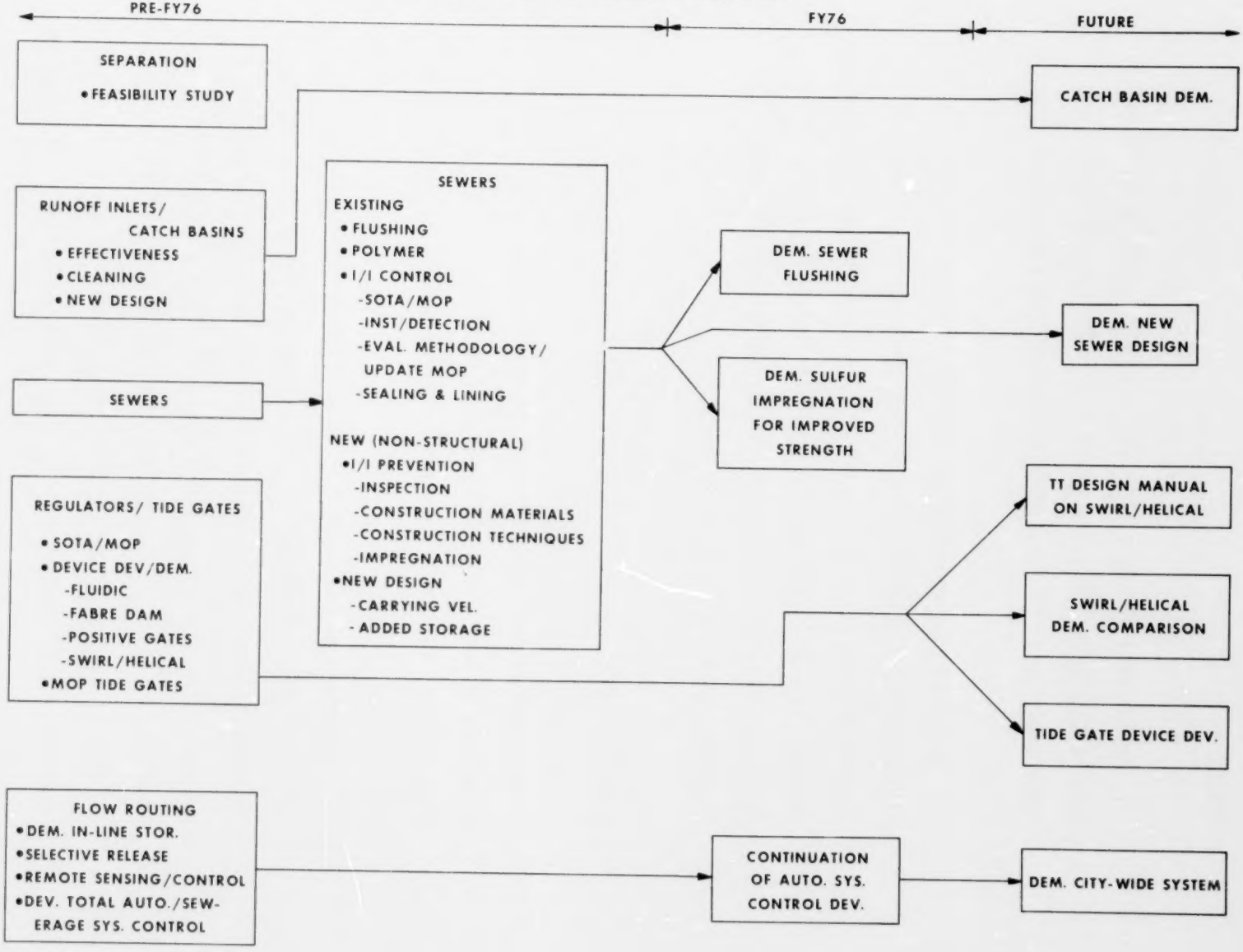
COLLECTION SYSTEM CONTROLS (Illustration XIV)

The next category, collection system control, pertains to those management alternatives concerned with wastewater interception and transport. These alternatives include sewer separation; improved maintenance and design of catch basins, sewers, regulators and tide gates; and remote flow monitoring and control. The emphasis, with the exception of sewer separation, is on optimal utilization of the existing facilities and fully automated control. To accomplish this an extensive and dependable intelligence system is necessary.

Catch Basins

An ongoing project is assessing the value of catch basins as they are presently designed and maintained. Optimized design and maintenance for removing solids before sewerage system entry is also being investigated.

COLLECTION SYSTEM CONTROL



Sewers

Solids deposition in lines has always been a plague to effective maintenance. Recently the significance of such loads as a major contributor to first flush pollution has been recognized.

Work is being conducted on new sewer designs for low flow solids carrying velocity to alleviate sewer sedimentation and resultant first flush and premature bypassing; and also on sewer designs for added storage. During this fiscal year or during FY 77, we anticipate a project to demonstrate periodic sewer flushing, also for first flush relief.

Flow Routing

An ongoing project mentioned earlier with the Cith of San Francisco is developing an automatic operational model for real-time control. Future demonstration of the system is anticipated.

A serious problem results from infiltration and inflow and has been well defined and countermeasures developed in previous program studies. We are currently conducting a project to develop practices for determining infiltration and its economic analysis. During the current fiscal year we plan to sponsor further studies to evaluate strength increases and erosion resistance from sulfur impregnation of concrete pipe. Since pipe costs are significant in

construction grants, an increase in strength could lead to a decrease in pipe materials and construction costs.

Regulators and Tide Gates

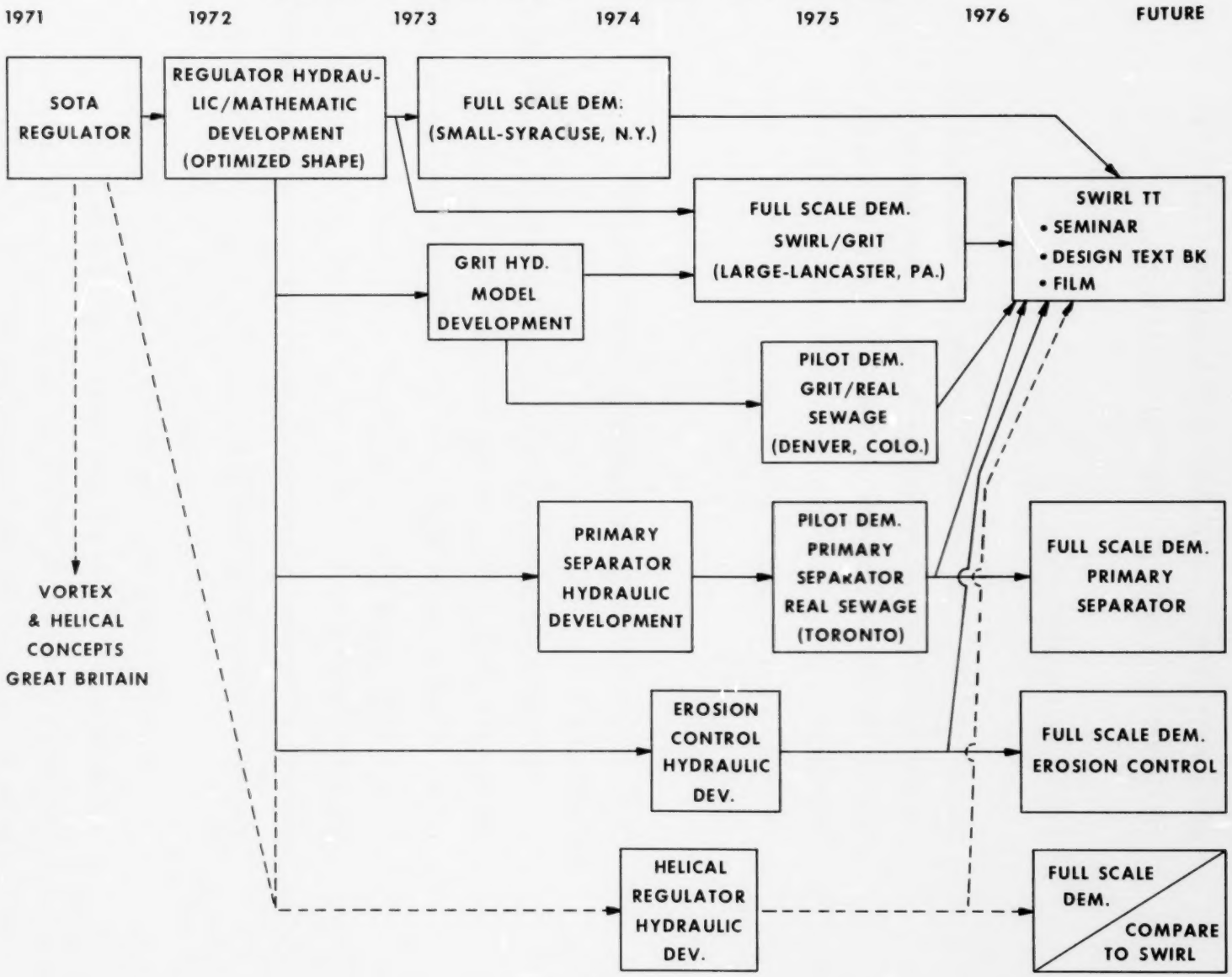
Conventional regulators and tide gates malfunction and cause excessive overflows and backwater entry to the sewerage system. The new improved devices such as fluidic and positive control regulators have been developed and demonstrated. The swirl and helical devices are significant enough to single out on a separate illustration.

Swirl and Helical Device Development (Illustration XV)

The dual functioning swirl device showed outstanding potential for providing both quality and quantity control. The device requires no moving parts, thus eliminating power costs and O&M problems. It is a small, ultra-high rate device of simple construction that can take the place of the inefficient conventional flow control regulators. In conjunction with its ability to control flows, the device can treat solids effectively at highly varying overflow rates.

In 1971 the SOTA report on regulators suggested a British device using vortex flow patterns could regulate flow and simultaneously remove solids. Based on this concept a hydraulic model investigation by the Program during 1972-1973 produced a

SWIRL AND HELICAL DEVICE DEVELOPMENT



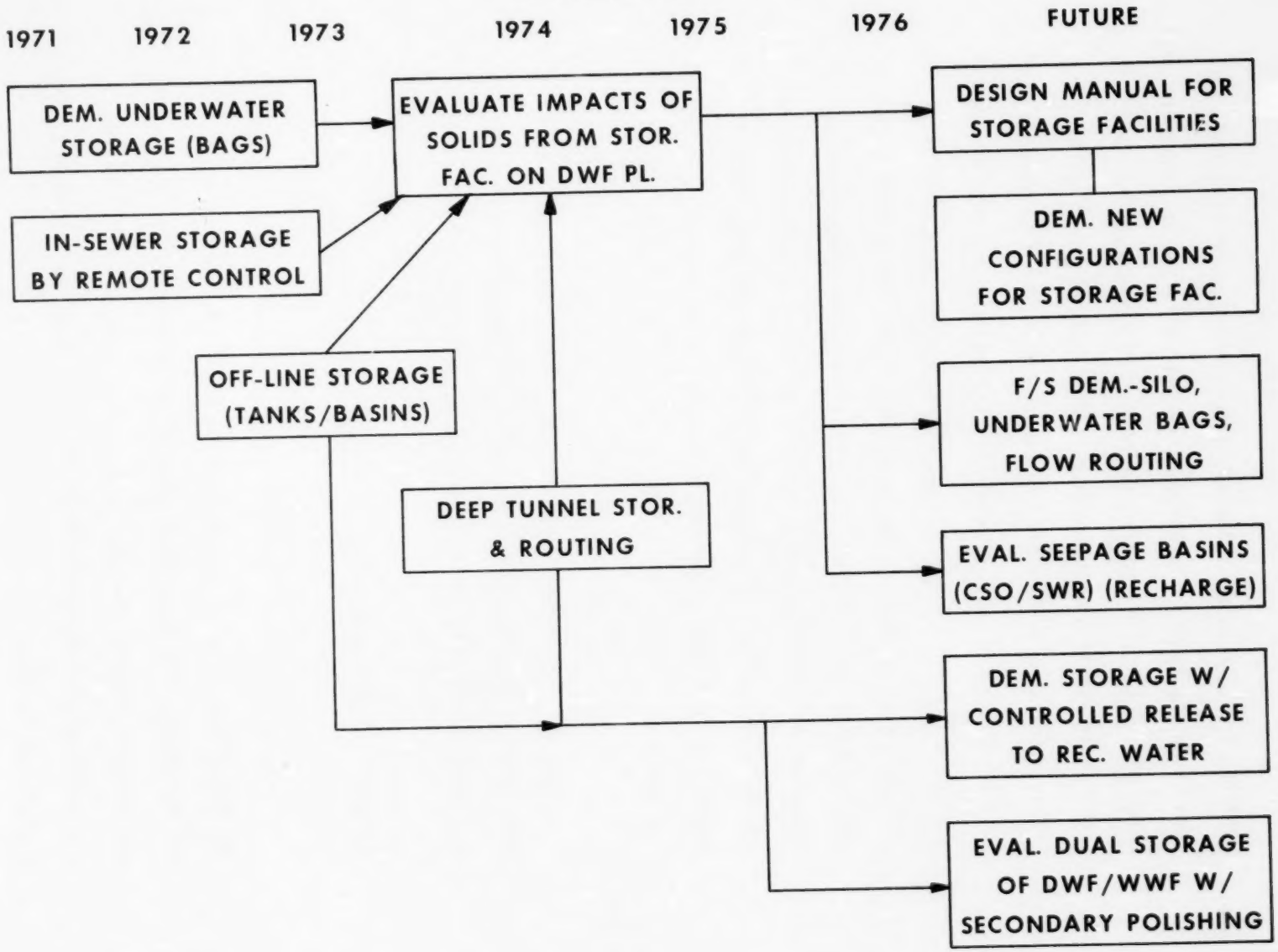
universal design being successfully demonstrated in Syracuse; and now being employed for a large-scale demonstration in Lancaster, PA Also during 1973-1974 model development was conducted to formulate swirls for degritting and primary clarification. During 1975, pilot studies were conducted in Denver on the swirl degritter, and in Toronto on the swirl clarifier. Evaluations are proving satisfactory from both sites. These solids separation devices have high trade-off potential for other M&I flows. Development of the swirl concept for erosion control has just been completed. It is hoped that full-scale demonstrations of the degritter, clarifier, and erosion control device will be conducted and that complete technology transfer documentation on the swirl concept will be implemented.

The 1971 regulator SOTA also lead to the development of a helical flow regulator/solid separator. A comparison of a full-scale swirl and helical regulator is anticipated.

STORAGE (Illustration XVI)

Storage is perhaps the most cost-effective method available for reducing pollution resulting from combined sewer overflows and managing urban stormwater runoff. Furthermore, it is the best documented abatement measure in present practice. (Storage. with the resulting sedimentation that occurs, can also be thought of as a treatment process.)

STORAGE


1971
1972
1973
1974
1975
1976
FUTURE
DEM. UNDERWATER STORAGE (BAGS)
IN-SEWER STORAGE BY REMOTE CONTROL
OFF-LINE STORAGE (TANKS/BASINS)
EVALUATE IMPACTS OF SOLIDS FROM STOR. FAC. ON DWF PL.
DEEP TUNNEL STOR. & ROUTING
DESIGN MANUAL FOR STORAGE FACILITIES
DEM. NEW CONFIGURATIONS FOR STORAGE FAC.
F/S DEM.-SILO, UNDERWATER BAGS, FLOW ROUTING
EVAL. SEEPAGE BASINS (CSO/SWR) (RECHARGE)
DEM. STORAGE W/ CONTROLLED RELEASE TO REC. WATER
EVAL. DUAL STORAGE OF DWF/WWF W/ SECONDARY POLISHING

Storage facilities possess many of the favorable attributes desired in storm flow control: (1) they are basically simple in structural design and operation; (2) they respond without difficulty to intermittent and random storm behavior; (3) they are relatively unaffected by flow and quality changes; and (4) they are capable of providing flow equalization and, in the case of sewers and tunnels, transmission. (Frequently they can be operated in concert with regional dry-weather flow treatment plants for benefits during both dry- and wet-weather conditions.) Finally, storage facilities are relatively fail-safe and adapt well to stage construction.

Storage facilities may be constructed in-line or off-line; they may be open or closed; they may be constructed inland and upstream, or on the shoreline; they may have auxiliary functions, such as flood protection, sewer relief, and flow transmission. (And they may be used for hazardous spill containment during dry weather.)

Storage concepts investigated by the program include concrete holding tanks, earthen basins, tunnels, underground and underwater containers, underground "silos," gravel packed beds with overhead construction, natural and mined under and above ground formations, and the use of abandoned facilities and existing sewer lines.

Inherent in many of these storage schemes is the pumping/bleeding back of the stored flow to the DWF plant during off-peak hours. The impacts of this increased load on the DWF plant (both from a hydraulic and increased solids point of view) is an important consideration and is presently being investigated in an ongoing project (Envirex). Once this impact information is available we feel we could summarize the SOTA in the form of a design manual (Post FY 77).

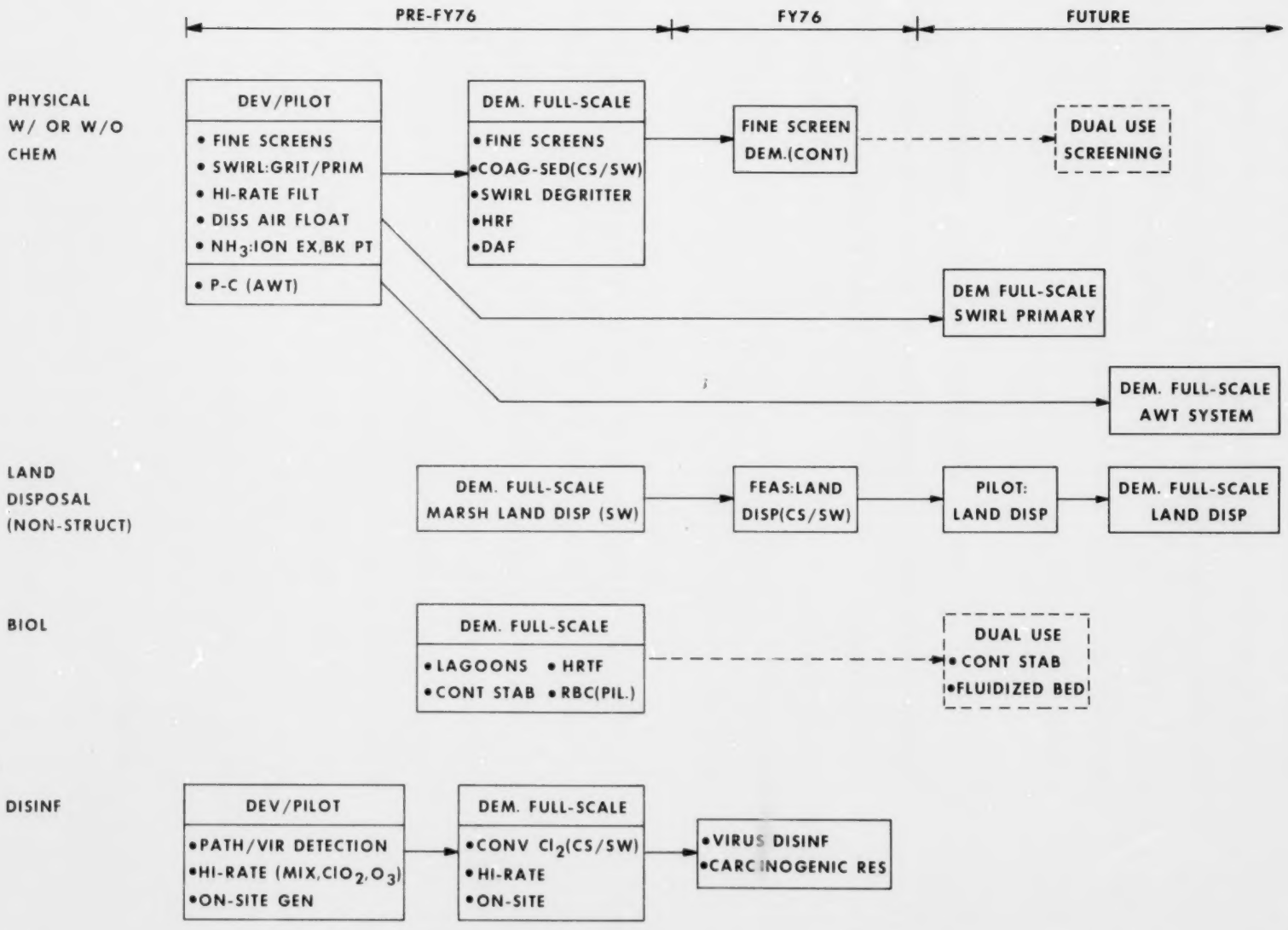
The feasibility of off-line storage and deep tunnel storage along waterways for selective discharge based on least receiving water impacts is presently being investigated in Rochester. This concept along with dual DWF and WWF storage, will be demonstrated in our post FY 76 plans as part of a tie-in to Construction Grants.

Future program plans include the investigation of new storage configurations, such as floating storage facilities, cofferdams, storage under piers, etc. Full-scale demonstration of some of the more promising configurations, e.g., silos and underwater bags, is also desirable.

TREATMENT (Illustration XVII)

Due to adverse flow conditions and unpredictable shock loading effects, it has been difficult to adapt existing treatment methods to storm-generated overflows, especially the microorganism dependent biological processes. The newer physical/chemical treatment

TREATMENT


PRE-FY76
FY76
FUTURE
PHYSICAL W/ OR W/O CHEM
DEV/PILOT
• FINE SCREENS
• SWIRL:GRIT/PRIM
• HI-RATE FILT
• DISS AIR FLOAT
• NH_3:ION EX,BK PT
• P-C (AWT)
DEM. FULL-SCALE
• FINE SCREENS
•COAG-SED(CS/SW)
•SWIRL DEGRITTER
•HRF
•DAF
FINE SCREEN DEM.(CONT)
DUAL USE SCREENING
DEM FULL-SCALE SWIRL PRIMARY
DEM. FULL-SCALE AWT SYSTEM
LAND DISPOSAL (NON-STRUCT)
DEM. FULL-SCALE MARSH LAND DISP (SW)
FEAS:LAND DISP(CS/SW)
PILOT: LAND DISP
DEM. FULL-SCALE LAND DISP
BIOL
DEM. FULL-SCALE
• LAGOONS • HRTF
• CONT STAB • RBC(PIL.)
DUAL USE
• CONT STAB
•FLUIDIZED BED
DISINF
DEV/PILOT
•PATH/VIR DETECTION
•HI-RATE (MIX,ClO_2,O_3)
•ON-SITE GEN
DEM. FULL-SCALE
•CONV Cl_2(CS/SW)
• HI-RATE
• ON-SITE
•VIRUS DISINF
•CARCINOGENIC RES

techniques have shown more promise in overcoming these adversities. To reduce capital investments, projects have been directed towards high-rate operations approaching maximum loading boundaries. Applications include pretreatment or roughing, main or sole treatment, and particularly with micro-strainers and filters, polishing devices.

This fiscal year we will invest in a grant continuation to further compare three different fine screens for combined sewer overflow treatment. In the near future, if money permits, we would like to implement a full-scale swirl primary treatment demonstration.

Physical/Chemical Treatment

Physical processes with or without chemicals, such as: fine screens, swirl primary and swirl degritters, high-rate filters, sedimentation, and dissolved air flotation, have been developed and demonstrated by the program. Ammonia removal and an advanced physical-chemical-adsorption system have also been developed and tested at the pilot level. Physical processes have shown importance for stormwater treatment because of their adaptability to automated operation, rapid startup and shut-down characteristics, high-rate operation, and very good resistance to shock loads.

Land Disposal

We are presently demonstrating the use of marshlands for dis-

posal of stormwater in Minnesota, and are about to embark on a feasibility study of land disposal for combined sewage and stormwater. If land disposal proves feasible, our next steps will be an actual controlled demonstration.

Biological Treatment

The following biological processes have been demonstrated: contact stabilization, high-rate trickling filtration, rotating biological contactors, and lagoons. The first three have had positive evaluation, but must operate conjunctively with DWF plants to supply biomass, and require some form of flow equalization.

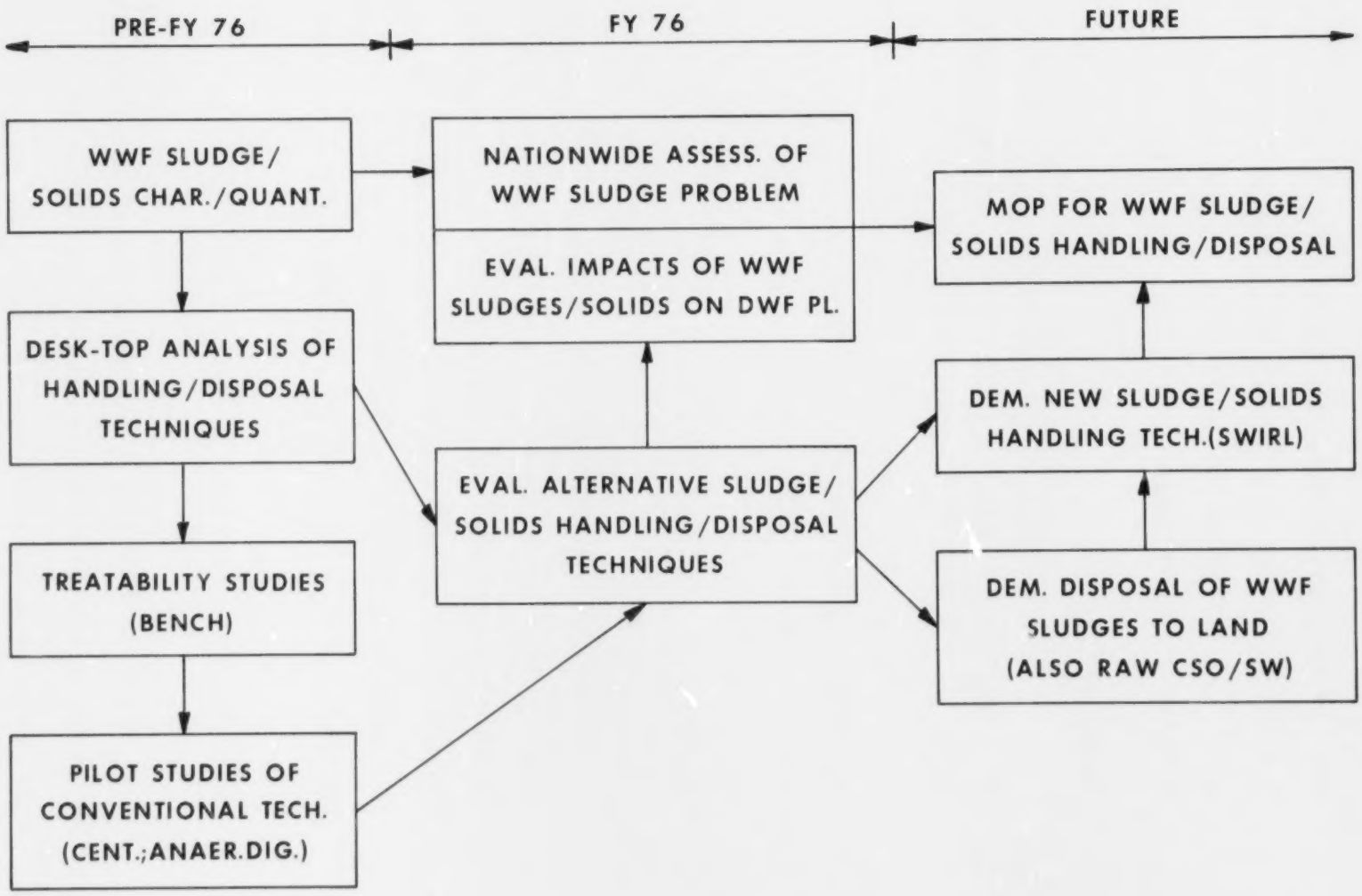
Disinfection

Because disinfectant and contact demands are great for storm flows, research has centered on high-rate applications by mixing and more rapid oxidants, i.e., ClO_2 and O_3; and on-site generation. Because of new concerns, a grant supplement this fiscal year will allow viral disinfection and carcinogenic chlorine residual compound studies tied onto a full-scale demonstration in Syracuse.

SLUDGE/SOLIDS (Illustration XVIII)

Due to the documented deleterious effect of CSO on the quality of receiving waters, WWF sludge handling and disposal has been held-off in concession to the problems of treating the combined over-

SLUDGE/SOLIDS


PRE-FY 76
FY 76
FUTURE
WWF SLUDGE/ SOLIDS CHAR./QUANT.
NATIONWIDE ASSESS. OF WWF SLUDGE PROBLEM
EVAL. IMPACTS OF WWF SLUDGES/SOLIDS ON DWF PL.
MOP FOR WWF SLUDGE/ SOLIDS HANDLING/DISPOSAL
DESK-TOP ANALYSIS OF HANDLING/DISPOSAL TECHNIQUES
DEM. NEW SLUDGE/SOLIDS HANDLING TECH.(SWIRL)
EVAL. ALTERNATIVE SLUDGE/ SOLIDS HANDLING/DISPOSAL TECHNIQUES
TREATABILITY STUDIES (BENCH)
DEM. DISPOSAL OF WWF SLUDGES TO LAND (ALSO RAW CSO/SW)
PILOT STUDIES OF CONVENTIONAL TECH. (CENT.;ANAER.DIG.)

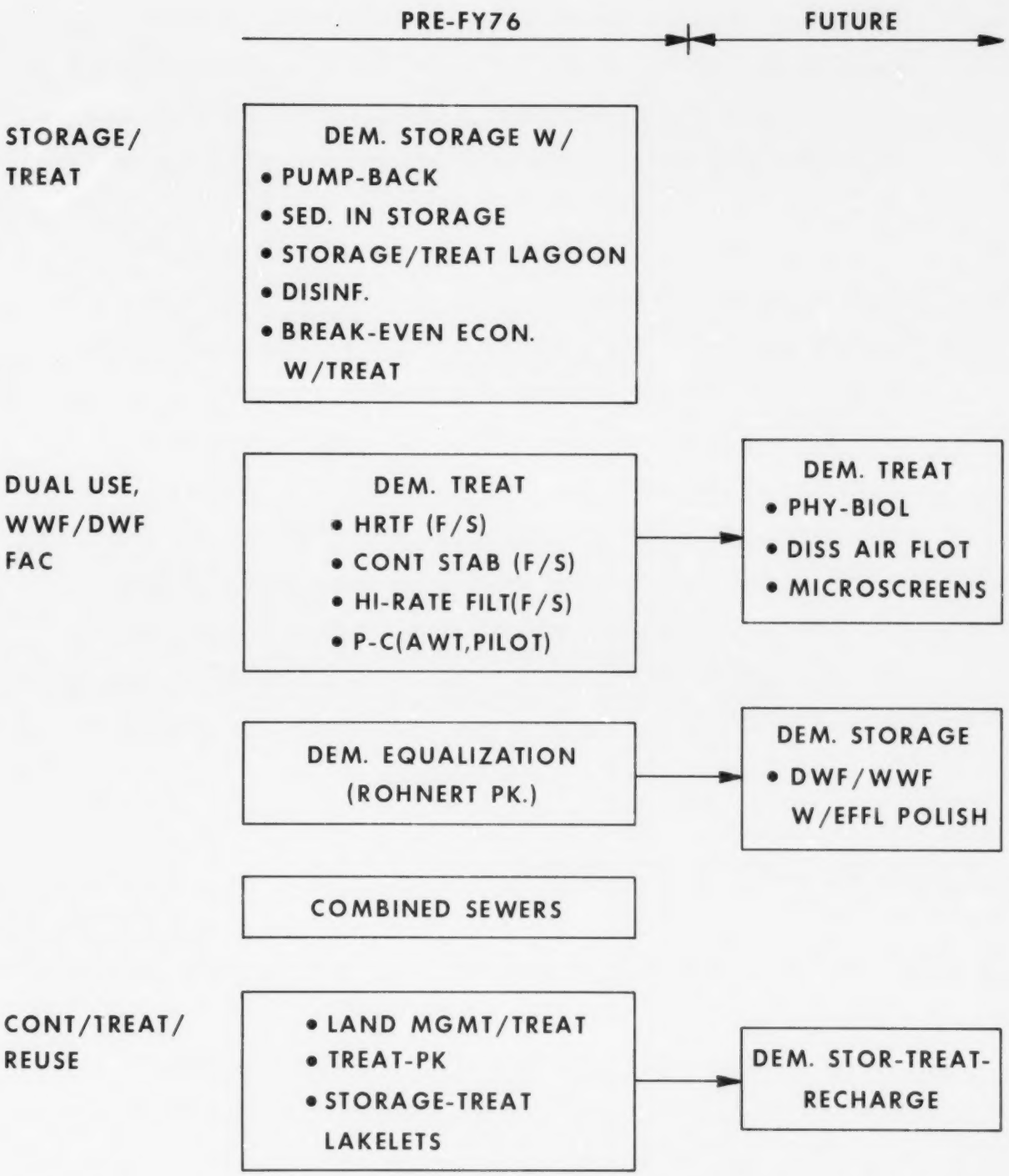
flow itself. Sludge handling and disposal should be considered an integral part of CSO treatment because it significantly affects the efficiency and cost of the total waste treatment system.. Flow characterization studies show that the annual tonnage of WWF solids is at least equal to and in most cases greater than solids from DWF.

The Program recognized the need for defining the problem and, in FY 73, awarded a contract to characterize and preliminarily quantify wet-weather flow sludge and solids and perform treatability studies. Follow-up work will evaluate pilot-scale thickening-centrifugation, and bench-scale anerobic digestion. During FY 76 alternative sludge handling/disposal techniques will be evaluated and a nationwide assessment of the sludge problem will be conducted. As part of this assessment, the "impacts" of returning WWF sludges and solids to the DWF plant and the need to classify grit from organics will be evaluated. In the future we would like to demonstrate land disposal of WWF sludges and investigate new techniques, such as the use of the swirl device for sludge thickening.

INTEGRATED SYSTEMS (Illustration XIX)

By far the most promising and common approaches to urban stormwater management involve the integrated use of control and treatment with an areawide multidisciplinary perspective. When a single method is not likely to produce the best possible answer to

INTEGRATED SYSTEMS



a given pollution situation, various treatment and control measures may be combined for maximum flexibility and efficiency.

Integrated systems is divided into (1) Storage/Treatment, (2) Dual Use WWF and DWF Facilities, and (3) Control/Treatment/Reuse.

Storage/Treatment

Where there is storage, there is treatment by settling, pumpback to the municipal works, and sometimes disinfection; and treatment, which receives detention, provides storage. In any case, the break-even economics of supplying storage must be evaluated when treatment is considered. The program has demonstrated all of these storage-treatment concepts on a full-scale basis.

Dual Use, WWF/DWF Facilities

The concept of dual use is -- maximum utilization of wet-weather facilities during nonstorm periods and maximum utilization of dry-weather facilities during storm flows for total system effectiveness. The program has demonstrated the dual use of high-rate trickling filters, contact stabilization, and equalization basins. On a pilot scale we have evaluated dual-use advanced physical-chemical treatment; and we are in the process of demonstrating large-scale, high-rate filtration.

In Fiscal Year 77 we are planning to investigate the dual use potential of dissolved air flotation at our existing Milwaukee pilot by determining design and operation for DWF for the establishment of joint WWF/DWF criteria and a manual. Another FY 77 planned project will evaluate the use of a sedimentation-activated sludge system for DWF, switched to a high-rate, dissolved air flotation-contact stabilization system for WW from highly infiltrated sanitary sewers in Clatskanie, Oregon. The same tanks will be used for both wet and dry-weather operations. Hopefully, in FY 77 we will also be able to evaluate the dual-use of microscreens for raw CSO treatment and DWF secondary effluent polishing. It is anticipated that ORD can ride piggy-back on Construction Grants again, for both the Clatskanie and the microscreening projects.

In the future it is important to evaluate triple-use storage for DWF and WWF along with secondary effluent polishing.

It should also be mentioned that combined sewers themselves are dual use systems.

Control/Treatment/Reuse

The sub-category, "Control/Treatment/Reuse" is a "catch-all" for all integrated systems. As the prime consideration, it is reasonable to apply the various non-structural and land management techniques to reduce downstream loads and treatment costs.

Various studies and a demonstration have indicated the feasibility of the treatment-park concept. In Mt. Clemens, MI, a series of three "lakelets" has been incorporated into a park development. Treatment is being provided so that these lakes are esthetically pleasing and allow for recreation and reuse for irrigation.

The project in Houston focuses on how a "natural drainage system" can be integrated into a reuse scheme for recreation and aesthetics. Good land use management will allow runoff to flow through low vegetated swales and into a network of wet-weather ponds, strategically located in areas of porous soils. This system will cause some of the runoff to seep into the ground and retard the flow of water downstream, thus preventing floods caused by development and enhancing pollution abatement. The concept of considering urban runoff as a benefit as opposed to a wastewater, in a new community development, will be employed and evaluated.

TECHNICAL ASSISTANCE/TECHNOLOGY TRANSFER (Illustration XX)

The final program area of consideration is concerned with "Technical Assistance" and "Technology Transfer." Within the Technical Assistance category are such items as consultation to Federal, state, local, and foreign governments; participation in national and international conferences and seminars; and response to public information requests. In the past few years technical

SIGNIFICANT DOCUMENTS COMPLETED

1. ASSESSMENT - PROBLEMS OF CSO/SW
2. CSO SEMINAR REPORTS
3. MOP - I/I PREVENTION & CORRECTION
4. MOP - REGULATION & MGMT
5. DESIGN MANUALS - SWIRL: REGULATOR/DEGRITTER/EROS. CONTROL
6. DESIGN MANUAL - HELICAL REGULATOR/SEPARATOR
7. ASSESSMENTS - SOURCES/IMPACTS OF URBAN RUNOFF POLLUTION
8. ASSESSMENTS - SAMPLING/FLOWRATE MEASUREMENT
9. ASSESSMENT - IMPACT OF DEICING
10. MOP'S - DEICING CHEMICAL USAGE/STORAGE & HANDLING
11. ASSESSMENT - SOTA URBAN SW MGMT & TECHNOLOGY
12. USERS MANUALS - SWMM, VERSION I & II
13. COURSE MANUAL - SWMM APPLICATION
14. MOP - DETERMINATION OF FLOWRATES/VOLUMES
15. ASSESSMENT/MOP - STORMWATER MODELS
16. MOP - PROCEDURES FOR SW CHARC./TMT STUDIES
17. MOP - SEDIMENT & EROSION CONTROL

assistance has occupied 20% of program time. While the areas of consideration within technical assistance may change somewhat, it is anticipated that this level of effort will grow; especially with the increased emphasis on 208/201 planning in the wet-weather flow area. Requests in these areas are demanding much more of an involvement than in the past. We are being asked to review more grant applications and documents, and lecture more frequently for EPA Headquarters and the Regions.

The Technology Transfer area covers the formal dissemination of program findings in the form of actual project reports, films, journal papers, SOTA reports, and manuals of practice and instruction. To date we have published approximately 125 reports, and it is the intent here to concentrate on the "user" type of document.

Significant Documents Completed

Reports generated by the program have received widespread recognition both within this country and abroad. Many have been referenced by EPA Headquarters and used for 201/208 studies. I'd like to highlight some. The first reports, Item No. 1, set the pace for EPA's program by identifying stormwater and combined sewer overflow as major sources of water pollution. Our manuals of practice on infiltration/inflow and regulators, Nos. 3 and 4, flagged two prime and basic problems leading to fruitful counter-measure research and a national emphasis on I/I control. Specific

research products coming out of the regulator MOP were the swirl and helical devices -- resultant design manuals are listed as Nos. 5 and 6. No. 8 sites two instrumentation reports for flow analysis which have proven to be highly useful to the engineering community, including Construction Grants. Report Nos. 11 through 17 relate to Approach and Solution Methodology, the goal of the program.

Significant Documents Anticipated (Illustration XXI)

In the immediate future, we will be releasing the previously mentioned national assessment document, and a refined SWMM users manual; along with two other assessments: one on the WWF sludge handling and disposal problem, and the other on pathogens in storm-water.

Ongoing work will also lead to an updated SOTA and a planning document providing guidance and examples for total municipal studies. (Other significant documents anticipated from ongoing projects are listed, along with some major documents from anticipated "Post FY 76" work.)

RUNOFF POLLUTION CONTROL: FY 76 (Illustration XXII)

This table summarizes the FY 76 projects, associated costs, and their status. Our total extramural budget is $800K. I am not taking time to reiterate each since they were previously mentioned in the context of how they fitted into our development plans. What

SIGNIFICANT DOCUMENTS ANTICIPATED

FY 76

ASSESSMENT - NATIONWIDE SW/CSO CHARACTERIZATION/IMPACTS/COSTS

USERS MANUAL - SWMM VERSION III

ASSESSMENT - WWF SLUDGE HANDLING/DISPOSAL PROBLEMS/IMPACTS

ASSESSMENT - PATHOGENS IN SW & CSO

SOTA/PLAN. GUIDE - UPDATE S&CSO MGMT & TMT/TOT APPROACH METH

DESIGN MANUAL - SWIRL: PRIMARY TMT

SOTA - URBAN WATER MANAGEMENT MODELING

MOP - I/I ANALYSIS, PREVENTION & CONTROL

INSTRUCTION MANUAL - S&CSO TECHNOLOGY

POST FY 76

MOP - POLLUTION CONTROL FROM CONSTRUCTION ACTIVITIES

MOP - REFINED SOLUTION METHODOLOGY

MOP - LAND MANAGEMENT

DESIGN MANUAL - STORAGE FACILITIES

CONSOLIDATED DESIGN TEXT - SWIRL & HELICAL

RUNOFF POLLUTION CONTROL PROGRAM: FY 76	$K	STATUS
SO: COMBINED SEWER POLLUTION CONTROL		
DEMO NON-STRUCTURAL SOURCE CONTROL; ST CLEANING/FLUSHING	124	PROPOSALS UNDER REV/ SAN JOSE, APWA/CINN/BOS.
DEMO AUTO CONTROL OF CS SYS (CONT S-803743, SAN FRAN)	130	BEING PROCESSED
INCORP SLUDGE TREAT OPT PROG INTO SWMM USER'S MANUAL (AMEND 802411, UNIV OF FL)	43	PROCESSED
FIELD EVAL OF AUTO SAMPLER, IN SITU TOC ANALYZER, ADD DISINF STUDIES (CONT S-802400, ONONDAGA CO.)	80	BEING PROCESSED
EVAL ALTERNATIVES FOR ULTIMATE DISPOSAL OF RAW/TREATED WW SOLIDS AND EVAL FEAS OF LAND DISPOSAL OF RAW CSO/SW (CONT 68-03-0242 ENVIREX)	30	BEING PROCESSED
EVAL STRENGTH IMPROVEMENT OF IMPREGNATED CONCRETE PIPE (AMEND 802651, TEXAS WATER QUALITY BOARD)	30	BEING PROCESSED
EVAL ELECTROMAGNETIC FLOWMETER FOR S&CSO APPLICATION (CONT 68-03-0341, CUSHING ENGR)	32	PROCESSED
TRANSLATION OF FOREIGN REPORTS FOR SOTA UPDATE (AMEND 68-03-2228, M&E)	7	PROCESSED
COMMITTED OVERRUNS	9	PROCESSED
SO: SEWERED & UN-SEWERED POLLUTION CONTROL		
F/S DEMO OF HYDROPHOBIC/ICEPHOBIC MATERIAL TO MITIGATE ICE ADHESION (CONT 68-03-0359, BALL BROS RES CORP)	40	BEING PROCESSED
EVAL EFF OF OFF-STREAM DET-RET MEASURES AS SEDIMENT CONTROL DEVICES (CONT R-803066-01, HOWARD UNIV)	11	BEING PROCESSED
SWR RECEIVING WATER IMPACT ANALYSIS/POLLUTANT LOADING DETERMINATIONS	186	MILW (PRE-PROPOSAL)/ PHILA/SYRACUSE/PATTERSON/ FITCHBURG/HOUSTON/RICH/ ATLANTA
DET VOLUMES AND FLOW RATES FOR STEEP SLOPE SEWERS (AMEND 68-03-0302, UNIV OF ILL)	7	PROCESSED
SO: HYDROLOGIC MODIFICATION		
DEMO SEDIMENT/EROSION CONTROL TECHNIQUES (CONT S-803724, UNIV OF SOUTH CAROLINA)	70	UNDER REVIEW
TOTAL FY 76 RESOURCES	799	

I would like to point out, is that all line item proposals have been received, and a number have been processed. In other words, we are in good shape this year!

RUNOFF POLLUTION CONTROL: FY 77 (Illustration XXIII)

This table contains our planned FY 77 tasks with estimated costs. Since they have all been covered previously, again, I won't go into detail.

The anticipated FY 77 extramural budget is $875K. We have good prospects for most of these projects. I have added five more priority tasks below the line, which we also have prospects for, to indicate potential accomplishments if an additional $650K was obtained for FY 77. The five tasks include two important manuals of practice, one for land management and one for storage design which will cover pertinent cost savings areas. The helical regulator is ready for full-scale demonstration, and like its sister, the swirl, its cost savings implications weighed against the multi-billion dollar estimates, are tremendous. We also have an opportunity to ride piggy-back onto a dual use microscreening construction project to demonstrate another important concept.

In another cost saving opportunity, we can reestablish our full-scale test loop and make final evaluations of our developed monitoring instruments. These instruments are foundation devices for the program.

RUNOFF POLLUTION CONTROL PROGRAM: FY 77	$K
SO: COMBINED SEWER POLLUTION CONTROL	
DEMO NON-STRUCTURAL SOURCE CONTROL; FLUSHING OR ST. CLEANING	150
DEMO SCREENING/DAF FOR DUAL DWF/WWF TMT.	OTHERS
EVAL. DAF/CONTACT STABILIZATION FOR DUAL DWF/WWF TMT.	100
SO: SEWERED & UN-SEWERED POLLUTION CONTROL	
EVAL. TMT-PARK CONCEPT FOR CITY-WIDE APPROACH TO CSO CONTROL	100
CSO REC. WATER IMPACT ANALYSIS/POLLUTANT LOADINGS	400
SO: HYDRAULIC MODIFICATION	
EVAL. SED./EROS. CONTROL TECHNIQUES, NORTHERN PLAINS	75
USERS MANUAL - POL. CONTROL FROM CONSTRUCTION ACTIVITIES	50
TOTAL ANTICIPATED BUDGET	875
SO: COMBINED SEWER POLLUTION CONTROL	
DEMO HELICAL FLOW REG./SOLIDS-LIQUID SEPARATOR	200
STORAGE DESIGN MANUAL	50
EVAL. SCS DEVELOPED INSTRUMENTATION	100
DEMO DUAL USE FULL-SCALE MICROSCREENING	100
SO: SEWERED & UN-SEWERED POLLUTION CONTROL	
MANUAL OF PRACTICE FOR LAND MANAGEMENT	200
ADDITIONAL REQUIRED	650

CAPITAL COSTS COMPARISONS FOR SCS CONTROL/TREATMENT (Illustration XXIV)

In this illustration we are trying to show a capital cost comparison for various SCS control and treatment methods.

As you can see, sewer separation is very costly with a national average of $20,000/acre. In-system control storage costs were found to be as low as $0.02 and $0.25/gal for Detroit and Seattle, respectively. These figures represented 1/10th the cost for large off-line facilities, and 1/25th the costs for separation in Detroit and Seattle, respectively. Off-line storage varies from $0.03 to $4.75/gal depending on whether earthen or concrete basins are employed.

Per acre costs can only be given in wide ranges since they significantly vary with climate, receiving water, terrain, degree of urbanization, sewer network configuration, etc. Per capita and per acre unit costs may be applicable for gross estimating; but it is best to fix unit costs per gallon for storage, and per mgd for treatment, as design factors for the user engineer confronted with site-specific conditions.

These data are based on a limited number of specific projects; thus they represent only a range of placement. In extrapolating these costs into master plan systems for cities, the totals frequently approach $500 - $1,000 per capita.

TYPICAL CAPITAL COSTS FOR SCS CONTROL/TREATMENT

(ENR 2000)

COMPONENT DEVICES	$/GAL	$/MGD	$/ACRE
SEPARATION			10,000 (SEATTLE) 6,500 (DES MOINES) 32,000 (CLEVELAND) 20,000-NATIONAL AVE.
STORAGE			
• IN-LINE	0.02 - 0.25 (DETROIT) (SEATTLE)		400 (SEATTLE) 250 (MINNEAPOLIS)
• OFF-LINE			
-EARTHEN	0.03-0.26		
-CONCRETE TANKS	1.00-4.75		7,000 (JAMAICA,NYC)
TREATMENT			
• PHYSICAL W&W/O CHEMICALS			
-FINE SCREENING/MICROSTRAINING		5,000/12,000	2,000/13,000
-SEDIMENTATION		10,000-50,000	3,500-6,500
-HI-RATE FILT		70,000	10,000
-DISS AIR FLOAT		40,000	6,500 (MILWAUKEE)
-SWIRL		6,000 (SYRACUSE) 2,000 (LANCASTER)	500(SYRACUSE) 500(LANCASTER)
•BIOLOGICAL			
-CON. STAB/TRICK. FILTER		80,000	1,700
-LAGOONS		17,000	5,000
•PHYSICAL-CHEMICAL SYSTEMS		150,000-2×10^6	
•DISINFECTION			
-CONVENTIONAL		1,500	
-HI-RATE(STATIC MIXING)		900	
INTEGRATED SYSTEMS			
•STORAGE/TRMT/REUSE		1×10^6(KINGMAN LAKE)	10,000(KINGMAN LAKE)
-TREATMT-PARK CONCEPT		17,000(MT. CLEMENS)	5,000(MT. CLEMENS)
LAND MANAGEMENT			
•STRUCTURAL			
-DIVERSION BERMS			160
•NON-STRUCTURAL			
-STREET CLEANING			7

Physical treatment costs range between $2,000 to $35,000/mgd; whereas physical with chemical treatment varies between $35,000 and $80,000/mgd. Biological treatment ranges between $17,000 and $80,000/mgd depending on whether land is available for lagooning or if we resort to contact stabilization or trickling filtration. As can be seen from the table, costs for the swirl at $2,000/mgd and $500/acre are considerably lower than other forms of treatment installation.

Bringing your attention to land management, it is seen from preliminary figures that we can potentially derive cost-effectiveness by including these techniques.

It must be mentioned that the various alternatives offer different degrees of removal which will have a significant bearing on the selection process.

SEATTLE: IN-LINE STORAGE IS COST-EFFECTIVE (Illustration XXV)

A case study illustrating cost-effectiveness by Seattle's flow routing approach follows:

Costs

The Seattle in-line storage system covering 13,250 acres costs $5.3M which is equivalent to $400 per acre as opposed to tens of thousands of dollars per acre for other alternatives. A specific

SEATTLE: IN-LINE STORAGE IS COST-EFFECTIVE

(REMOTE MONITORING WITH SUPERVISORY CONTROL)

D.A. = 13,250 ACRES

- LOW COSTS
  - -$5.3M = $400/ACRE ($5/AC/YR O&M)
    VS. $1,000'S-$10,000'S PER ACRE FOR OFF-LINE ALT.
    AND $10,000 PER ACRE FOR SEPARATION
  - -QUASI-STRUCTURAL:
    - ○ 50% COST FOR COMPUTERS/SOFTWARE
    - ○ 50% COST FOR FOR HARDWARE
- OVERFLOW/POLLUTANT REDUCTION
  - -50%-60% OVERFLOW REDUCTION (SUPERVISORY CONTROL)
  - -90% OVERFLOW REDUCTION (EXPERIMENTAL AUTOMATIC CONTROL)
  - -68% POLLUTANT REDUCTION (8 PARAMETERS)
- EFFECTIVENESS
  - -1-2 MG/L RIVER D.O. INCREASE
  - -50% RIVER COLI REDUCTION.

Seattle study revealed $10,000 per acre for separation. The low cost is attributed to a quasi-structural system which takes advantage of the existing combined sewer network; and control gates installed at strategic points only. The system is highly signal and computer oriented with minimal hardware requirements. In fact, one-half the costs were for computers and related software. Of course, in-line storage is site specific since implementation of the concept requires a relatively large and flat existing combined system.

Pollutant Reduction

Overflow and pollutant reduction from 12 major overflow points averaged 55 and 68 percent, respectively. Also, 90 percent of the overflow volume was reduced by experimental automatic control.

Effectiveness

Effectiveness of the system is proven by a one to two mg/l D.O. increase and a 50% coliform reduction in the receiving water.

DES MOINES: CONTROL COSTS VS. D.O. VIOLATIONS (Illustration XXVI)

Based on a study for the City of Des Moines using a simplified

DES MOINES: CONTROL COSTS VS. VIOLATIONS OF DO STANDARD (4 PPM)

OPTIONS	TOTAL ANNUAL COST ($/YR)	% OF PRECIPITATION EVENTS VIOLATING STANDARD
1. DWF TERTIARY TREATMENT	6.3M	85
2. WWF 25% BOD REMOVAL	1.6M	82
3. WWF 75% BOD REMOVAL	10.8M	58
4. DWF SECONDARY TRT ONLY	0	85-86

receiving water model, four control alternatives were compared considering cost and true effectiveness in terms of frequency of D.O. standard violations.

As the illustration depicts, 25 percent BOD removal of WWF coupled with secondary treatment of DWF results in slightly higher D.O. levels in the receiving water than tertiary treatment and no control of urban runoff. The annual cost of 25 percent BOD removal for WWF is 25 percent of the cost for tertiary treatment. However, existing DWF treatment facilities exhibit a comparable effect to these two options at no additional cost. A significant increase in the minimum D.O. levels of the Des Moines River is obtained by 75 percent BOD removal of WWF. However, the annual cost of this level of control is significantly higher than the cost of tertiary treatment. The application to Des Moines demonstrated clearly, the overwhelming effect of urban runoff pollution on critical D.O. concentrations. The cost-effectiveness of various treatment alternatives can be determined realistically only by a continuous analysis of the frequency of water quality violations.

In the selection of the "best" control strategy, other factors may become important, such as: (1) recovery of receiving waters from shock loads during runoff periods, (2) local and regional water quality goals, and (3) public willingness to pay the costs associated with each level of control.

CONCLUSION

The pertinent research needs in the areas of solution methodology, non-structural and structural control and treatment techniques, and integrated systems have been covered in enough detail so we must conclude with an item of overlying importance. Mandates of the law are upon us, emphasizing WWF pollution control; monies are being spent at large scale by EPA and others for water pollution cleanup. In order for governments to execute their function in this area properly, it is a must that WWF pollution be considered.